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Vol. XIX, Part I, p. 21, line 22, insert " no " between " is " and " more ".

The following Original Articles will appear in our next issue (July 1924).

Original Articles

SOME COMMON INDIAN BIRDS.

No. 27. THE TAILOR-BIRD (*ORTHOTOMUS SUTORIUS*).

BY

T. BAINBRIGGE FLETCHER, R.N., F.L.S., F.E.S., F.Z.S.,
Imperial Entomologist;

AND

C. M. INGLIS, M.B.O.U., F.E.S., F.Z.S.

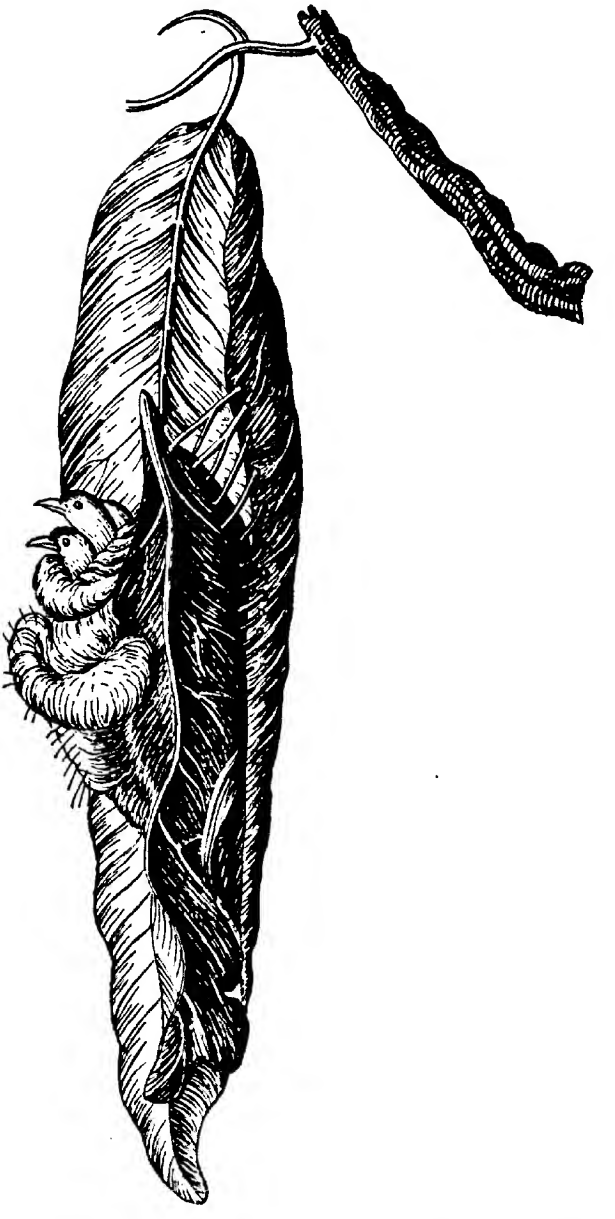
THE Warblers include a very large number of kinds of small birds which, with few exceptions, are plainly coloured and alike in both sexes. Over one hundred species occur within Indian limits, many being migrants, passing the summer in Central or Northern Asia, whilst others are permanent residents in the Plains and lower ranges of the Hills. Amongst these latter are included the Tailor-birds, so called from the remarkable skill which they display in the construction of their nests which are placed in a receptacle made by sewing together the edges of one or more leaves, and of these little birds the most common and widely-distributed is the Indian Tailor-bird (*Orthotomus sutorius*). This is a tiny greenish-brown bird, whitish below, in general appearance like a wren, but with a decidedly longer tail; if further description is needed, it may be noted that the forehead is reddish, shading off into ashy-grey on the back of the head, and that on each side of the neck there is a short black bar or spot, usually concealed but plainly visible when the bird stretches its neck to utter its note, which it is doing continually. Indeed, as Cunningham has so aptly put it, "whenever memory reverts to the experiences of summer in the Plains of India, it can hardly fail to recall the loud

shouts of the Tailor-birds, as they travel about ceaselessly among the shrubs. Even at those times of day when the breathless heat and cruel glare have reduced almost all other birds to relative silence; when even the crows sit about in pairs in the shade, gasping with widely gaping bills and incapable of anything beyond whispered conversation, and when the still and fiery air is only rarely disturbed by the querulous whistle of a kite, even then the Tailor-birds are all alive with noisy excitement. Whilst listening to them, or to the cries of other loud-voiced small birds, one realizes the beauty of the dispensation that has decreed that in the animal kingdom there should be no necessarily direct ratio between size and vocal power; an elephant with a voice on the scale of that of a tailor-bird would have been a nuisance to a whole district! Even the longest use and wont leave it a ceaseless marvel how such pygmies can manage to make such a hubbub, whilst they run and creep about among the bushes, more like little brown mice than any feathered creatures. They have two common calls, the first consisting of an urgent repetition of the syllable 'pēēt,' and the second, even more insistent and sounding, 'pe peep, pe peep, pe peep, pe peep.' Long after most other birds are silent; after even the crows and mynahs have finally settled down for the night, and only an occasional belated kite is audible, their call may still be heard issuing from the flower-beds and shrubberies, where the birds continue to run mouse-like about in the gathering gloom, jumping after the insects lurking among the leaves. When highly excited over anything they shout their loudest, and, with their tails so excessively elevated that they come to point obliquely forwards over their backs, look more like demented wrens than anything else. Whilst engaged in hunting over a shrub they run quickly along the twigs, shouting noisily all the while, and every now and then snatching at insects, and, even when flying, they continue to call aloud with a reckless expenditure of breath." The above has been quoted at length, as it seems to be a charming character-sketch of the little bird in question, which, although inconspicuous and apt to be overlooked, will now perhaps be recognizable to our readers. The typical race, as shown on our

plate, of the Indian Tailor-bird (*O. sutorius sutorius*) occurs throughout the Plains and lower Hills of India, Ceylon, and North and Central Burma, being replaced in Southern Burma, Siam and the Malay Peninsula by the Malay Tailor-bird (*O. sutorius maculicollis*), which differs by having white streaks on the ear-coverts.

As noted above, Tailor-birds are mainly insectivorous in their diet. The late Mr. C. W. Mason examined the stomach-contents of four birds at Pusa and found them to consist entirely of insect remains, mainly of small beetles, bugs, ants and flies; Mr. D'Abreu found much the same in the case of three birds examined at Nagpur. They seem, therefore, to be useful little birds to have in a garden.

The breeding-season of the Indian Tailor-bird is mainly in June and July, but nests may be found from April until August. The structure and design of birds' nests in general may vary from just nothing at all, the eggs being laid on the bare ground, to elaborate mounds such as are constructed by the Bower Birds, but for ingenuity, as applied to its construction and concealment, the Tailor-bird's nest is hard to beat. Pennant seems to have been the first to give any description of it and we reproduce the rather quaint figure given in his *Indian Zoology* (second edition; 1790) where he says that in India "the brute creation are more at enmity with one another than in other climates; and the birds are obliged to exert unusual artifice in placing their little broods out of the reach of an invader. Each aims at the same end, though by different means. Some form their pensile nest in shape of a purse, deep, and open at top: others with a hole in the side; and others, still more cautious, with an entrance at the very bottom, forming their lodge near the summit. But the little species we describe, seems to have greater diffidence than any of the others: it will not trust its nest even to the extremity of a slender twig, but makes one more advance to safety by fixing it to the leaf itself. It picks up a dead leaf, and, surprising to relate, sews it to the side of a living one, its slender bill being its needle, and its thread some fine fibres; the lining, feathers, gossamer, and down. Its eggs are white. The colour of the bird light-yellow: its length three inches,



Nest of the Tailor-bird amongst mango leaves (Pennant's *Indian Zoology* (1790), Pl. 10.)

its weight only three-sixteenths of an ounce, so that the materials of its nest, and its own size, are not likely to draw down a habitation that depends on so slight a tenure." So far as it goes, Pennant's account is fairly accurate except in the statement that the bird picks up a dead leaf and sews it on to the side of a living one. The dry leaves which are often found attached to the outerside of the nest are accounted for by the fact that these leaves, which have originally been pierced by the bird whilst they are still living and attached to the tree or plant, often die and decay *in situ*, either as a direct result of the injury caused to them or by interference with the free access of air to the tissues.

The nest may be placed at any elevation, such as high up in a mango-tree or low down in a brinjal-plant but more usually they are built comparatively low down, often within a couple of feet of the ground. The kind of leaf selected seems to be rather immaterial, provided that it is fairly large and sufficiently strong to hold the strain of the stitches, and in gardens the leaves of mango, guava and brinjal are often used. As a rule only one or two leaves are used but occasionally, when the nest is placed on a plant with small leaves, such as oleander, a dozen leaves may be fastened together. Generally, the nests hang down more or less vertically, as shown in Pennant's figure, but sometimes they lie almost horizontally with the opening between the lower edges of the leaves, so that the nest is well protected in rainy weather.

The actual construction of the nest has been observed by Mr. A. G. Pinto, as reported by Dewar in his *Birds of the Plains*. In this case the nest was placed in the leaf of a *Dracæna* plant growing on a verandah and we cannot do better than quote our authority for what took place:—"One of the leaves of the plant was so curved that its terminal half was parallel with the ground. Upon this she commenced operations. The first thing she did was to make with her sharp little beak a number of punctures along each edge of the leaf. In this particular case the punctures took the form of longitudinal slits, owing to the fact that the veins of the *Dracæna* leaf run longitudinally . . . . . Having thus prepared the leaf, she disappeared for a little and returned with a strand of

cobweb. One end of this she wound round the narrow part of the leaf that separated one of the punctures from the edge; having done this, she carried the loose end of the strand across the under surface of the leaf to a puncture on the opposite side, where she attached it to the leaf and thus drew the edges a little way together. She then proceeded to connect most of the other punctures with those opposite to them, so that the leaf took the form of a tunnel converging to a point. The under surface of the leaf formed the roof and sides of the tunnel or arch. There was no floor to this, since the edges of the leaf did not meet below, the gap between them being bridged by strands of cobweb. This was a full day's work . . . . . She next went on to line with cotton this *cul-de-sac* which she had made in the leaf. She, of course, commenced by filling the tip, and the weight of the lining soon caused the hitherto horizontal leaf to hang downwards, so that it eventually became almost vertical, with the tip pointing towards the ground. When lining the nest the bird made a number of punctures in the leaf, through which she poked the lining with her beak, the object of this being to keep the lining *in situ* . . . . . All this time the edges of the leaf that formed the nest had been held together by the thinnest strands of cobweb, and it is a mystery how these can have stood the strain. However, before the lining was completed, the bird proceeded to strengthen them by connecting the punctures on opposite edges of the leaf with threads of cotton. Her *modus operandi* was to push one end of a thread through a puncture on one edge and the other end through a puncture on the opposite edge of the leaf. The cotton used is soft and frays easily, so that that part of it which is forced through a tiny aperture issues as a fluffy knob, which looks like a knot and is usually taken for such. As a matter of fact, the bird makes no knots: she merely forces a portion of the cotton strand through a puncture, and the silicon which enters into the composition of the leaf catches the soft, minute strands of cotton and prevents them from slipping . . . . . Sometimes the connecting threads of cotton are sufficiently long to admit of their being passed to and fro, in which case the bird utilizes the full length."

It is only the hen-bird which constructs the nest. Although the two sexes are coloured much alike, in the breeding-season the male bird acquires very elongated middle tail-feathers, projecting about two inches beyond the normal length of the tail, so that the sexes are readily distinguishable. We cannot say whether his extra length of tail is an impediment to nest-building or whether it makes him too proud to work or whether he is merely lazy; but to the hen-bird must be given all the credit of the wonderful method of nest building. Aitken, however, in his *Common Birds of Bombay*, implies that it is the cock-bird which builds.

The leaves containing and concealing the nest are fastened together with any suitable material that is available such as cobweb, caterpillar silk, thread, wool, or vegetable fibres. When a nest is being built near a house the bird will often make use of threads of cotton or loose strands from a coir mat. Jerdon says, "I have seen a Tailor-bird at Saugor watch till the native tailor had left the verandah where he had been working, fly in, seize some pieces of thread that were lying about, and go off in triumph with them; this was repeated in my presence several days running."

The nest itself is a neat cup, about three inches deep and two inches in diameter, constructed of wool, cotton, with a few hairs and fine vegetable fibres, the cavity being always very softly lined. Three or four (more frequently three) eggs are laid, measuring about 16 by 12 mm., the ground-colour being either reddish-white or pale-bluish-green, the former being the more common, but all the eggs in any one nest always belong to one or the other type; the markings on the eggs consist of blotchings and clouds tending to form a bold irregular cap around the larger end, and also of smaller, brownish-red specks and splashes scattered more or less over the whole surface of the shell. When sitting on the eggs the hen-bird sits very close and does not usually fly out until the nest is actually touched or shaken.

The young birds are well looked after by their parents for some time after they have left the nest and small family-parties, consisting of the parents and their young, may often be seen at that time of the year.

WHEAT FORECASTS IN THE PUNJAB.

BY

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VALUE OF CROP STATISTICS.

IN India the main source of Government income has always been land revenue. As long as this was collected in kind, there was no urgent necessity for the preparation of crop statistics; but when cash rates were imposed, it became desirable for the Government to get some estimates of the actual outturn of the crops from the sale of which the cash revenue required would be obtained. This has been particularly necessary in a province like the Punjab, where the landowners are mainly small proprietors, cultivating their own holdings, and where, therefore, it is very difficult to deduce assessment rates from the rents paid by the tenants to landowners. But the War gave an additional importance to estimates of outturns of food-grains. At that time the outturn of food-grains ran short of requirements all over the world, and in every country Governments began to estimate their stocks in hand and their probable requirements. India being a self-supporting country, the problem did not arise there so acutely, but large exports during the War followed by a particularly bad harvest in 1920-21 caused a shortage, which caused prices to rise considerably. The export of wheat was prohibited under a law framed to meet War emergencies. This action gave rise to great "controversy, the sterile consumer of time and energy."[1] Great doubt was felt as to whether the stocks in hand were or were not adequate for feeding the population. The difficulty of coming to an estimate as to their amount, and the

[1] Marshall. *Industry and Trade*, Preface.

importance to Government politically of securing that the population had enough food to live on, all drew increased attention to the value of accurate crop statistics.

Crop statistics originally prepared for land-revenue purposes.

These are, however, recent developments and the methods at present in force were based originally on the requirements of the land-revenue system. It was Akbar who first substituted a cash assessment for payments of land revenue in kind. He "fixed his claim at one-third of the gross produce, and in order to realize the revenue on this basis his officials determined the average yield of every crop grown in the country, and fixed cash rates representing one-third of this average yield valued on the results of ten years' experience. The area sown with each crop was recorded season by season, and the demand on each peasant was calculated by applying the sanctioned rates to the area which he had cultivated."[1] "The seasonal crop statistics were an essential feature of the regulation system of assessment. These statistics were not compiled by the village accountants, who were at this period servants of the village, and not of the State; season by season the measurers and the writers appeared on the scene, and if their emoluments were in part at least a charge on the peasants, the burden must have been heavy."[2] Though these methods were improved on by the British Government, the principle of assessment remained the same. "The rule laying down the standard of assessment is as follows:—'The assessment of an estate will be fixed according to circumstances, but must not exceed half the value of the net assets,' a phrase which is defined as meaning 'the average surplus which the estate may yield after deduction of the expenses of cultivation, including profits of stock and wages of labour.' When the rents are fair competition rents, 50 per cent. of the rental is considered to be the measure of the half assets share

[1] Moreland. *India at the death of Akbar*, IV. i.
[2] Moreland. *India at the death of Akbar*, III, ii.

of rented land and the rates ascertained from these rents for all classes of soil are applied to the whole cultivation, whether by tenants or by the owners. The ascertainment of the rental is a comparatively easy matter with our present records wherever cash rents prevail, but considerable difficulty is encountered in converting produce rents into a cash rate. The area of each crop is of course known, but estimates have to be made of the outturns of each crop, the actual share received by the landlord and the prices obtained by him for his produce; all of which, owing to the uncertainty involved, are probably usually under-estimated. In practice, it is recognized that there are many reasons which may justify a Settlement Officer in assessing below the maximum standard, but he is required to state as accurately as possible what the half net assets are, and to give good reasons for any proposal to fix the Government demand much below that standard. No particular fraction of the *gross produce* is prescribed as the limit of the land revenue demand, the only limit being that just mentioned, viz., half the value of the net assets."[1] It is clear, therefore, that while a great deal of trouble has been taken to get accurate crop statistics for the purposes of assessment, yet with that object in view a Settlement Officer will always be afraid to impose a higher rate than is consistent with absolute safety. If he over-estimates the gross produce there is a danger of the settlement breaking down; if he under-estimates no great harm ensues except the slight loss to Government. His estimate is, therefore, like an engineer's estimate of the breaking strain of a bridge. It is essential that he should provide a large margin for safety. He is moreover an officer who moves about amongst the people and is bound to be influenced by the "inherent pessimism of the farmer"[2] in estimating the produce of his land. For all these reasons, while the method of obtaining crop statistics for settlement purposes has great value, there is an inevitable bias in the direction of under-estimating the outturn.

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[1] *Punjab Administration Report*, 1922-23, Vol. I, para. 258.

[2] Stuart, G. A. D. "The seasonal factor in crop statistics: A method of correcting for the inherent pessimism of the farmer." *Agri. Jour. India*, XIV, 2, April 1919.

PRESENT DAY IMPORTANCE OF PUNJAB WHEAT STATISTICS FOR THE LIVERPOOL WHEAT MARKET.

For land-revenue purposes what was required was not so much accurate statistics of outturn as a conventional figure on which a Settlement Officer could base his assessment. But with the development of the wheat export trade, combined with the possibility of the food supply of the population falling short of what is vitally necessary, a desire has arisen for getting results more in accordance with actual facts. The development of world's market of wheat is a modern phenomenon, and in this respect wheat together with rice and barley is to be differentiated from other food-grains such as *bajra* (*Pennisetum typhoideum*) and *jowar* (*Sorghum vulgare*) whose market is limited to India. "Under the rule of Rome the ports of the Mediterranean were united into a coherent market of wheat, and were indeed connected with a network of good roads. But during the greater part of history, few places, that were not near to great waters, could draw any considerable supply from distant lands, to meet their urgent demand when faced by a continued deficiency of their harvests."[1] "Indian records extending back into the eighteenth century show violent fluctuations of prices even in great central markets, such as Delhi: they show much more violent changes in secondary markets: while, in places remote from any metalled road, their movement upwards was limited only by the price of a man's life, after a series of bad harvests; and by the value of the grain as fuel, after a series of good harvests. Gradually the local unevennesses were smoothed out by the making of metalled roads and railways. Thus Sir Theodore Morison tells us that in the eighteenth century, and even later, a village of Northern India, which did not lie on its one great metalled road, and had no share in its scanty water communication, was in effect isolated: there was but slender accommodation in shallow grain pits for the surpluses of successive good harvests: and after bad harvests when those pits were exhausted, there was

[1] Marshall, *Industry and Trade*, App. I. c. Kingsley in *Hypatia* (Ch. XX) gives a picturesque description of the wheat export trade from Alexandria to Rome.

practically no further reserve on which to draw: so the price of the village went its own way, with but little reference to the prices even of the neighbouring country. But now 'the whole of Northern India is practically one market for food-grains, and the price of wheat in a district in which the crops have failed is the same, with but a very small addition for the cost of carriage, as the price in a district which had a bumper harvest.' In regard to India generally he concludes that before 1850 prices fluctuated violently, and fluctuated in different localities independently. After 1860 they were comparatively stable, and fluctuated simultaneously."[1] "The fact that wheat is an important article of international trade is not solely due to its popularity as a food. There are several other foods that are more widely consumed than wheat; there is milk, for instance, which is not an object of international trade at all. Wheat possesses special qualities that make it easy to buy and sell it. It does not deteriorate quickly; it can be eaten many months after it ripens; it can be easily carried from place to place without suffering much harm; it can be stored without loss; and, what is of almost more importance than these, it can be classified and graded into well-known kinds and can then be sold by description. Wheat at Karachi can be sold in Liverpool without moving it from Karachi, and without sending a sample to the buyer."[2] The principal exporting countries are as follows:—

Wheat exports (million tons).[3]

	1913	1921	Principal month of export[4]
1 Australia	1·2	2·8	February
2 Argentine	2·8	1·6	March
3 India	1·4	2·7	July
4 United States ..	2·7	7·6	September
5 Russia	3·3	0	October
6 Canada	3·5	4·0	November

The stoppage of Russian supplies has necessitated a great increase of outturn in other countries. This has been especially

[1] Marshall. *Industry and Trade*, App. I, i.

[2] Calvert. *Wealth and Welfare of the Punjab*, p. 144.

[3] *International Year Book of Agricultural Statistics*, 1909–1921, pp. 252–257.

[4] Weld. *The Marketing of Farm Products*, Ch. XII.

developed in United States. The Indian source of supplies is not so important in its amount as in the time when it arrives. The relatively small supplies from Australia and the Argentine are exported in February and March, the main supplies from the United States and Canada do not come till September and November. Indian wheat exported in July arrives at a time when the American and Canadian crops can only be approximately estimated. Should the carry-over from the last year be small and the Australian and Argentine crops be below average, the Indian wheat exporter may have the market at his feet, and be able to charge what he likes for his produce. The amount of the Indian wheat outturn has therefore a world-wide importance, and as the Punjab has 40 per cent. of the total Indian wheat acreage, the value of a correct forecast of the outturn of this province is obvious.

Commercial community approach Government.

With the development of the Indian wheat export has come an intensified desire for accurate crop statistics. "In 1883, a leading firm of Liverpool merchants interested in the wheat trade represented to the Secretary of State for India, through a member of Parliament, that the publication of information about crops in India, somewhat on the plan adopted by the United States Department of Agriculture, would be useful to persons engaged in business with that country."[1] Originally the statistics of outturn were prepared after the crop was gathered, but the commercial community found that this was too late to be of any service to them. The Government, therefore, decided to issue crop forecasts in advance so that the exporters might be in a position to estimate what amount would be forthcoming. It is, therefore, clear that these crop forecasts were mainly intended for the benefit of commercial people, though Government took care to safeguard itself by saying that they were primarily (*a*) for the general information of the public, and (*b*) for the information of Government, and only *secondarily*

[1] *A Manual on the Preparation of Crop Forecasts in India* (Department of Statistics, India), Ch. I.

for the benefit of the trade. But though these crop statistics were required now mainly for commercial rather than land-revenue purposes, the method of their collection remained essentially the same and tended to suffer from the same under-estimate as previously.

Wheat crop forecasts.

Four forecasts each were prepared for the principal exporting crops of wheat and cotton and a lesser number for four other crops. Of these the first two forecasts for wheat and cotton deal with area only and are admittedly rough estimates. The last two forecasts are the important ones. The third forecast is issued in April and gives the area and outturn at the time of harvest. The fourth forecast, which is issued in the middle of May, gives estimates when the crop is nearly harvested. The two forecasts generally approximate to each other though in years such as 1923 when the rain damaged crops on the threshing floor the estimates may differ considerably. These last two reports stand on a different footing from the preliminary ones both as regards objects and constitution: for, whereas the last two reports being largely concerned with outturn are estimates of the quantity of crop actually to be handled, the earlier reports are only aids to conjecture as to what that quantity will be.[1]

Proposal to have separate yield estimates for each village.

In compiling such forecasts, very accurate estimates of area can be obtained from the village *patwaris*, who are required at each harvest inspection to note on the area under each particular crop. But it is in estimates of yield that difficulties arise. The outturn of a particular year can be obtained if we know its area in acres and the yield per acre, provided the yield is uniform over the area. If the yield is not uniform then it is impossible to obtain an accurate measure of the outturn, because whatever kind of average we take,

[1] *Manual on the Preparation of Crop Forecasts in India* (Department of Statistics, India).

whether the mean, the mode or the arithmetical mean, in any case the total area multiplied by this average does not equal the sum of the small areas over which the yield is uniform multiplied by their respective yields, which is the true outturn.* To illustrate this, suppose a district in which there are two tahsils, one containing 200,000 acres of irrigated wheat with a yield of 20 maunds an acre and the other containing 10,000 acres of unirrigated wheat yielding 10 maunds an acre, the actual outturn is 41 lakh maunds, whereas the total area being 210,000 acres and the arithmetical mean of the yield being 15 maunds per acre the outturn obtained by multiplying the area by average yield is 31·5 lakh maunds, which bears very little relation to the actual outturn. In cases where the yield is nearly uniform the difference would not be so great and a fairly accurate result may be obtained by taking the average for the areas. The previous practice has been for the Director of Agriculture to estimate normal outturns for unirrigated and irrigated areas for the district as a whole. These estimates are based on the Tahsildars' estimates of tahsil average yields and modified by the Director of Agriculture's personal experience, and by that of the Deputy Director of Agriculture in districts where such an official has been appointed. The arrangements suggested, however, should lead to more accurate results. The yields in different areas of a district vary enormously with inevitable error in the estimate. The proposal is, therefore, to get a yield estimate from each *patwari* (village accountant) for each class of land in his village, i.e., *seilab* (irrigated by percolation), *barani* (irrigated by rainfall), *chahi* (irrigated by well) and canal irrigated. In this way a separate yield estimate will be obtained for each small area over which the yield is uniform. This method will do away with all the inaccuracies of estimates which inevitably follow from an average yield over

* For let a_1 a_2 ..... a_n be small areas over which the yield is uniform.

y_1 y_2 ..... y_n be the yields per acre of these areas.

Then the total outturn is $y_1 a_1 + y_2 a_2 + \ldots\ldots + y_n a_n$ But this does not equal the average yield the total area which is $\frac{1}{n}(y_1 + y_2 + \ldots\ldots y_n)(a_1 + b_2 + \ldots\ldots a_n)$.

Here the average yield is taken as the arithmetic mean of all yields, but similar arguments would apply for an average based on any other principle.

the whole district. The *patwari* having given his estimate of yield in this way the area under each crop is known accurately from the land-revenue papers, and each *patwari* can, therefore, estimate the outturn of his village. A forecast of considerable accuracy can thus be obtained, provided the *patwari's* estimates of yields are accurate.

ESTIMATES SHOULD BE IN MAUNDS AND SEERS PER ACRE RATHER THAN IN PERCENTAGES OF NORMAL YIELD.

Hitherto we have been considering the question of average over a district, but the term average is also used in connection with the average crop in a particular area taken over a series of years, and it was originally considered impossible for the *patwari* to give an estimate of yields in maunds and seers per acre. It was thought that he could only give his impression of the particular crop as being a good or bad one in terms of a percentage of the average yield.[1] For this purpose the Director of Land Records worked out a quinquennial average based on actual crop experiments taken on small areas which were considered typical or average. But apart from the possibilities of errors in such experiments the question arose in what way these areas were average. Statistically there are three such kinds of averages. (1) The mode, i.e., the figure which most frequently occurs in a series of varying homogeneous quantities of which the normal or average is required. (2) The median, i.e., the figure which divides the series of varying quantities in two equal parts; in other words, a figure such that the number of quantities in excess of it are equal to the number below it. (3) The ordinary arithmetical mean or average, that is, the sum of the quantities considered divided by their number. The fields on which such experiments were conducted would naturally give a result which was nearer the mode than the arithmetical mean. A Settlement Officer, in arriving at the rates of yield to be adopted for assessment purposes in addition to considering the results of actual crop experiments, wisely places a good deal of dependence on the

[1] *Manual on Preparation of Crop Forecasts in India*, Ch. II. *Report of the Indian Sugar Committee*, para. 361. *Agri. Jour., India*, XIV, 2, April 1919.

results of his personal local enquiries from cultivators and others supplemented of course by his own observations. Such results tend pretty obviously to give a 'modal' average (or 'mode') rather than an arithmetical average or 'mean.' Fields for practical experiment by crop-cutting and weighment are selected generally in the light of an instruction to select 'average fields in an average village.' Thus the assumption of an average is a fundamental feature of the whole process, so that the experimental investigation moves more or less in a circle. If the man on the spot really knew the norm, or the average, and really calculated what percentage of that norm the actual crop represents, he would have to begin by making up his mind how many maunds and seers on an average each acre would produce. He really knows and does none of these things. Only one of them is essential, viz., the estimate of the number of maunds and seers to the acre, for the purposes of the forecast, and it is this estimate which we should endeavour to make the man on the spot prepare. For these reasons it seems desirable that the *patwari* should give the estimate in maunds and seers and not in percentages of an assumed normal crop. It is true that in so doing he will tend to under-estimate the outturn, (1) because, as has been pointed out above, the whole land-revenue assessment has a bias in favour of under-estimating.[1] (2) because the zemindars, on consultation with whom he will largely base his estimate, will always under-estimate their outturn with the object of obtaining a low assessment of land revenue, (3) because of the "inherent pessimism of the farmer"[2] which is notorious throughout the world. But in spite of this tendency to under-estimate, the relative values of *patwari's* estimates of yield have a very fair accuracy. The Punjab *patwari* is generally in close touch with all matters affecting the agriculture of his circle, and it would be impossible to find in the Punjab instances such as that quoted from Madras "where no village accountant kept any accounts and where all figures were invented at the close of the year."[3] The

[1] P. 234.

[2] Stuart. *Agri. Jour., India*, XIV, 2. April 1919.

[3] Id.

tendency to under-estimate will be more or less uniform from year to year, and it would be better to correct such an under-estimate by adding the necessary percentage to the total outturn rather than by attempting to doctor the result of each *patwari* in each village.

Estimates of outturn and consumption.

But though provincial estimates based on the *patwari's* estimates of yields for particular class of lands and villages will lead to an increased accuracy, the present method of taking district averages of irrigated and unirrigated crops has furnished results which are admittedly of great value to exporters. These estimates are given in the Season and Crop Reports. It is generally believed that exporters arrive at an approximation to the true outturn by adding about 33 per cent. to the official figures. Probably the official figures are nearer the true outturn than the exporters imagine.' We may assume then that the actual outturn is between the official figures and an amount 33 per cent. in excess of that. Let us suppose for the moment that the actual outturn is the official outturn multiplied by $1+x$, where x is the undetermined percentage to be added to the official estimate to arrive at the true figures—(x lying between 0 and $\frac{1}{3}$). This involves the assumption that the percentage under-estimate is the same from year to year, but that is a perfectly reasonable assumption, as, if there is an under-estimate, the same cause will act on it in successive years. If from this estimate of outturn we deduct the amount required for seed consumption within the province, and net exports (i.e., total exports *less* imports), we shall have the amount added to the stocks in hand in the province during the year. This amount may be negative. If it is added to the carry-over from the preceding year we shall have the total stocks in hand at the end of the year.

Estimates of wheat consumption must take into account that of other food-grains.

The estimates for consumption and stocks in hand can only be approximate, but an endeavour will be made to show that such

estimates may nevertheless be combined with the estimates of outturn for purposes of mutual check. It is clear that in estimating consumption other food-grains must be taken into consideration as well as wheat, and estimates of their outturn are also, therefore, necessary. These have also been taken in a similar manner to that of wheat from the Season and Crop Report. Estimates of outturn of other food-grains are compiled in a very similar manner to those for wheat, and it is reasonable to assume that if they are under-estimated, the amount of under-estimate will be proportional to that for wheat.

Deductions for seed and exports.

In making such estimates only round figures are of any value, and therefore the estimates will only be given in million tons to one decimal place. The deductions for seed are relatively small and an approximate estimate for seed is, for wheat, about 30 seers per acre (i.e., of the area over which it was sown[1]), and for other food-grains 5 per cent. of the outturn. The exports are obtained from the Internal Trade Report which has unfortunately been discontinued though exporters have strongly pressed for its renewal and proposals for that purpose are under consideration. The figures appended, however, will only give exports up to the year 1921-22 after which the Internal Trade Report was discontinued. The export figures may be taken to be strictly accurate within the limits necessary for the purposes of this discussion.

Consumption estimates.

It is in making estimates of consumption that there is the greatest possibility of error. Popular estimates vary from $\frac{3}{4}$ to 1 seer per day per individual. Sir Ganga Ram's figure for the whole of India works out to about half a seer per individual,[2] but this is probably too small for the Punjab, with a strong manly agricultural

[1] Roberts. *A Text-book of Punjab Agriculture*, p. 97.

[2] Sir Ganga Ram. *Agriculture: A Profession.* Address delivered at the Agricultural College, Lyallpur, on 27th March, 1923.

population. We may take therefore as a working hypothesis that the wheat consumption lies between ½ and 1 seer per day per individual, and for this purpose the nutritive value of a seer of other food-grains may be equated to that of a seer of wheat. As the Internal Trade Report deals with export from the Punjab, including Indian States, Delhi and North-West Frontier Province, it is necessary to check the consumption of the whole of this area. There are, however, certain Indian States for which there are no outturn returns. They are, however, Hill States which are self-supporting and from which the exports are negligible. The argument will not, therefore, be affected by excluding them from the population statistics on which consumption is based and also from the food outturn figures, and this has been done. The population of the area under consideration is 27 millions. Half a seer per day for this population amounts to 4·5 million tons. The actual consumption is assumed to be 4·5 multiplied by $1-\frac{1}{4}-y$, where y lies between 0 and 1. As the statistics given in the Internal Trade Report are for the financial year while the Season and Crop Report deals with the agricultural year, the wheat and gram statistics are in each case those of the succeeding year, e.g., the wheat and gram statistics for the financial year 1913-14 are taken from the Season and Crop Report of 1912-13. Other food-grains are all *kharif* crops with the exception of barley, the amount of which is so small that no great error will be caused by classifying it with the other food-grains and including the amount a year previously. It is impossible to isolate barley as there are no separate statistics given for the export of barley which is classified with other food-grains. This will serve to show how the following statement is arrived at :—

Wheat consumption (figures in million tons) for Punjab including Indian States, Delhi and N. W. F. Province.

1	2	3	4	5	6	7	8	
Year	Outturn	Seed	Balance	Net exports	Balance for consumption	Consumed	Stocks over	Net season carried over
1912-13	Wh. $(1-x)$ 4·1	0·3	$(1-x)$ 3·8	1·1	$2·7-3·8x$	$4·5+4·5y$	$5·0+6·6x-4·5-4·5y$	$a+0·5+6·6x-4·5y$
	G. 1·1	0·1	1·0	0·2	$0·8-1·0x$			
	F. 1·9	0·1	1·8	0·3	$1·5-1·8x$			
1913-14	Wh. 3·4	0·3	3·1	0·9	$2·2-3·1x$	$4·5+4·5y$	$4·3+5·8x-4·5-4·5y$	$a+0·3+12·4x-9·0y$
	G. 0·8	0·0	0·8	0·4	$0·4-0·8x$			
	F. 2·0	0·1	1·9	0·2	$1·7-1·9x$			
1914-15	Wh. 3·5	0·3	3·2	1·0	$2·2-3·2x$	$4·5+4·5y$	$4·5+5·8x-4·5-4·5y$	$a+0·3+18·2x-13·5y$
	G. 0·6	0·0	0·6	0·3	$0·3-0·6x$			
	F. 2·2	0·2	2·0	0·0	$2·0-2·0x$			
1915-16	Wh. 4·0	0·3	3·7	0·6	$3·1-3·7x$	$4·5+4·5y$	$5·5+6·6x-4·5-4·5y$	$a+1·3+24·8x-18·0y$
	G. 1·3	0·1	1·2	0·4	$0·8-1·2x$			
	F. 1·8	0·1	1·7	0·1	$1·6-1·7x$			
1916-17	Wh. 2·8	0·3	2·5	0·9	$1·6-2·5x$	$4·5+4·5y$	$3·1+4·3x-4·5-4·5y$	$a-0·1+29·1-22·5y$
	G. 0·5	0·0	0·5	0·2	$0·3-0·5x$			
	F. 1·4	0·1	1·3	0·1	$1·2-1·3x$			
1917-18	Wh. 3·2	0·3	2·9	1·0	$1·9-2·9x$	$4·5+4·5y$	$4·1+5·7x-4·5-4·5y$	$a-0·5+34·8x-27·0y$
	G. 0·9	0·0	0·9	0·3	$0·6-0·9x$			
	F. 2·2	0·3	1·9	0·3	$1·6-1·9x$			
1918-19	Wh. 3·7	0·3	3·4	0·6	$2·8-3·4x$	$4·5+4·5y$	$4·8+6·1x-4·5-4·5y$	$a-0·2+40·9x-31·5y$
	G. 1·5	0·1	1·4	0·6	$0·8-1·4x$			
	F. 1·4	0·1	1·3	0·1	$1·2-1·3x$			

Wheat consumption (figures in million tons) for Punjab including Indian States, Delhi and N. W. F. Province—concld.

1	2	3	4	5	6	7	8	9
Year	Outturn	Seed	Balance	Net exports	Balance for consumption	Consumed	Stocks over	Net stock carried over
1919–20	Wh. 3·1 / G. 0·5 / F. 2·4	0·3 / 0·0 / 0·2	2·8 / 0·5 / 2·2	0·4 / 0·2 / 0·1	2·4 + 2·8 x / 0·3 + 0·5 x / 2·1 + 2·2 x	4·5 + 4·5 y	4·8 + 5·5 x + 4·5 − 4·5 y	a − 0·1 − 46·4 x − 36·0 y
1920–21	Wh. 4·2 / G. 1·0 / F. 1·3	0·3 / 0·1 / 0·1	3·9 / 0·9 / 1·2	1·0 / 0·2 / 0·1	2·9 + 3·9 x / 0·7 + 0·9 x / 1·1 + 1·2 x	4·5 + 4·5 y	4·7 + 6·0 x + 4·5 − 4·5 y	a + 0·3 + 52·4 x − 40·5 y
1921–22	Wh. 2·4 / G. 0·4 / F. 2·2	0·3 / 0·0 / 0·2	2·1 / 0·4 / 2·0	0·0 / 0·2 / 0·1	2·1 + 2·1 x / 0·6 + 0·4 x / 2·1 + 2·0 x	4·5 + 4·5 y	4·8 + 4·5 x − 4·5 − 4·5 y	a − 0·6 − 56·9 x − 45·0 y

COLUMN 1. The year taken is the financial year ending on 31st March.

COLUMN 2. Wh. equals wheat, G. equals gram and F. equals other food-grains, i.e., barley, *bajra*, maize, *jowar* and rice. The wheat figures are taken for British territories, i.e., Punjab, N. W. F. Province and Delhi, from the Season and Crop Reports, and for the major Indian States from the Crop Forecasts. The minor Indian States which publish no Forecast are mainly Hill States which do not export and therefore their omission does not affect these figures. Their population is also omitted in the estimate of population. As the outturn of wheat and gram is given in the Season and Crop Report for the land-revenue year ending in September, it is clear that the figures for any particular year for wheat and gram will be entered under the subsequent financial year, and this has been done. The other food-grains with the exception of barley are *kharif* crops and therefore in that case the land-revenue year and financial year correspond. As the Internal Trade Report does not mention barley specially, it is impossible to isolate it, but the amount of barley is so small that no appreciable error will be caused by taking barley for the year subsequent.

COLUMN 3. Estimating wheat seed at 30 seers per acre and other food-grains at 5 per cent.

COLUMN 4 equals column 2 minus column 3.

COLUMN 6 is column 4 multiplied by $(1 - x)$ − column 5. x is that fraction which must be added to the estimated outturn to get the true outturn.

COLUMN 7. Population of Punjab, Delhi and N. W. F. Province, excluding minor Indian States, equals 27 millions. Consumption of 27 millions per year at half seer per head per day equals 4·5 million tons. The actual consumption equals $4{\cdot}5\,(1 - y)$, where y is a proportional fraction that must be added to the half seer to get the true consumption.

COLUMN 8 equals column 7 minus column 6.

COLUMN 9 is a plus totals of previous column 8. Where column 8 is negative it is subtracted. a denotes the stocks in hand at the end of the financial year of 1919–20.

LIMITS THAT MAY BE ASSIGNED TO ESTIMATES OF CONSUMPTION.

a is the assumed stock carried over at the commencement of the year 1912-13. Stock remaining at the end of 1921-22 is seen from the statement to be

$$a + 0{\cdot}6 + 56{\cdot}9\,x - 45{\cdot}0\,y.$$

Now x and y are fractions. It has already been shown that

x lies between 0 and $\frac{1}{3}$

y " " 0 " 1.

Put $x = \frac{1}{10}\,x_1$ $\quad y = \frac{1}{10}\,y_1$.

So that x_1 lies between 0 and $3\frac{1}{3}$

y_1 " " 0 " 10.

Then stock at end of 1921-22 $= a + 0{\cdot}6 + 5{\cdot}7\,x_1 - 4{\cdot}5\,y_1$ approximately.

Now at present there is no means of accurately estimating the amount of stocks in hand, though, as will be seen, a yearly census of the total wheat stocks in the province at the end of the year is under contemplation. In default of such a census there are some limits which may be assigned to the probable amount of stock held over at the end of the year. It is not unreasonable to assume that it does not exceed a million tons in any particular year. There is no reason to suppose that the amount of stocks held over was otherwise than normal at the end of the years 1911-12 and 1921-22. The stocks in hand at the end of both these years may therefore be assumed to be roughly the same, and the difference between them would be sufficiently small to be negligible for the purpose of the rough approximation which has been made for the purpose of this discussion.

Hence carry-over from 1911-12 = carry-over from 1921-22.

Or $a = a + 0{\cdot}6 + 5{\cdot}7x_1 - 4{\cdot}5y_1$ or $45y_1 = 57x_1 + 6$.

Now x_1 lies between 0 and $3\frac{1}{3}$.

Hence y_1 lies between $\frac{2}{5}$ and $4\frac{1}{3}$.

Hence y lies between 0·01 and 0·4 (roughly).

We may now put this into ordinary language. If we assume that the estimates of outturn for the last 10 years are correct, then

the average consumption per head will be 0·55 seer. If we assume that the estimates are 33 per cent. too small, then the average consumption per head must be 0·7 seer. It has been shown that the outturn must lie between these limits, and we can therefore deduce fairly close limits for the consumption per head, limits which, it has already been shown, are *prima facie* probable. Thus, though we cannot be certain of the accuracy of our estimates of outturn, and still less of the accuracy of our estimates of consumption, we can connect these estimates with each other in such a way as to use each as a check on the other.

Suggested census of stocks.

It will now be seen that far more valuable results could be obtained if we had estimates of the amount of the stocks in hand at the end of the financial year, as even if these estimates are liable to considerable error yet as before we might assume that the percentage of error remained constant from year to year, and therefore by a similar line of argument to that which has been applied to outturn and consumption, limits might be assigned within which the amount of stocks in hand must lie. The end of the financial year would be the best time for making such a census as it is both the time when the year for which exports are given commences and also the time when the wheat stocks have reached their lowest and when therefore it would be easiest to take a census of their amount, as then the great mass of wheat is in the *mandi* and there is little left with the zemindar. It has been proposed that such a census should be taken by Deputy Commissioners through Tahsildars, who will estimate the stocks with zemindars and in ordinary *mandis*. In cases of large *mandis* the estimates would be obtained from bazar *chaudhris*, big merchants or exporting firms. In each case it will be left to the discretion of the Deputy Commissioner to select such methods as he may choose. It is also proposed that Deputy Commissioners in making their estimates should not only give what they consider the probable amount of the stock in hand in the district but also the maximum or minimum limits which they consider possible for these stocks. This will enable us to get some

general idea of the possible errors in the estimates of stocks. Assuming that some rough idea of the stock in hand at the end of the year may be obtained by some such methods as this, we should then be in a position to check these results by our figures for outturn and consumption, which could again be used to check the results for stocks, and with each year an increasingly accurate estimate could be framed.

For example, if such a census of stocks had been held during the four years 1918-19 to 1921-22, and the amounts of stocks had been found to be b, b_0, b_1, b_2, and assuming that the real amounts were $b(1+z)$, $b_0(1+z)$, $b_1(1+z)$, $b_2(1+z)$ where z is a fraction (and may be negative), then we should have

$$\begin{aligned} b\ (1+z) &= a + 0{\cdot}2 + 40{\cdot}9x + 31{\cdot}5y \\ b_0(1+z) &= a + 0{\cdot}1 + 46{\cdot}4x + 36{\cdot}0y \\ b_1(1+z) &= a + 0{\cdot}3 + 52{\cdot}4x + 40{\cdot}5y \\ b_2(1+z) &= a + 0{\cdot}6 + 56{\cdot}9x + 45{\cdot}0y. \end{aligned}$$

Whence results could be obtained for a, x, y, z (b, b_0, b_1, b_2 being known). Such results, if used with caution, could give very valuable information, which could be used to criticise or confirm the accuracy of the methods employed in collecting statistics of outturn and stock. It has also been suggested that a further check on the accuracy of the results could be obtained from districts such as Hissar or Lyallpur, which have little road communication with outside districts, and where by getting figures for outturn, net export, consumption, and stocks for those districts alone, a further check might be made on the accuracy of the statistical methods employed for the province as a whole.

SUMMARY.

To sum up, crop statistics were originally collected for land-revenue purposes, and this involved an inevitable tendency towards under-estimating the outturn. But with the development of wheat export and with the increased anxiety on the part of Government to secure an adequate supply of food for the population has arisen a demand for statistics which are freed from bias. The substitution of village for district yield estimates would remove one source of

error but would not eliminate this bias. But estimates can be obtained for outturn, consumption, and stocks in hand. These estimates will probably be biased, but the bias may be assumed to be constant from year to year. By means of this assumption they may be used to check each other, with continually nearer approximations to true results. An example of how this might be done has been worked out, and though every endeavour has been made to take into consideration all the factors involved, it is possible that some may have been overlooked. The contention made is not so much that the results here obtained are strictly accurate, as that by some such method as that here indicated a far nearer approach to correct estimates of outturn, consumption, and stocks in hand could be obtained than has hitherto been possible.

A PRELIMINARY ACCOUNT OF THE INVESTIGATION OF COTTON WILT IN CENTRAL PROVINCES AND BERAR.*

BY

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THE wilt of cotton is the most important disease of cotton in the Central Provinces and Berar. The loss caused by it is not insignificant. In fact in these provinces it has spread to such an alarming extent, and is continuing to spread so much, that the Indian Central Cotton Committee is financing experiments for the study of this important problem, not only in these provinces but also in Bombay.

A paper on this disease was read before this Congress in Calcutta in 1921 but not before this Section. As a general account of this disease and of the loss caused by it is already given by Ajrekar and Bal in the paper[1] referred to, it is not necessary to give an account here once again. The considerable loss caused by wilt in the affected areas can be judged from the fact that at Nagpur out of 393 plants of AK2, a variety of *eeeum*, and 171 plants of AK4, a variety of *malvensis*, grown in pots containing soils from wilted fields of Akola and Nagpur Government Farms, only 23 AK2 and 54 AK4 plants are alive up to date, i.e., the loss of AK2 plants has been 95 per cent. and of AK4 68·5 per cent., while of the 255 AK2 plants and 273 AK4 plants grown in pots containing soil from non-wilted areas not a single plant has wilted.

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* Paper read at the Agricultural Section of the Indian Science Congress, Bangalore, 1924.

[1] *Agri. Jour. Ind.*, XVI, pp. 598-617.

Whatever difference of opinion there be regarding the extent of the loss caused by the disease, regarding the spread of the disease and regarding the immunity of certain varieties, there is no doubt that, so far, there has been an unanimity of opinion amongst mycologists and agriculturists that the wilt is caused by a fungus, a species of *Fusarium*, though I do not know what justification there is for holding this view except that it be because in badly wilted plants fungus mycelium has invariably been found and because cotton wilt in America has been known to be caused by a fungus called *Fusarium vasinfectum*. But I do not consider that as yet any satisfactory evidence has been produced to establish the fungal nature of the Indian disease. The only serious attempts so far made in India to prove the fungal origin of the disease have been by Butler[1] and by Ajrekar and Bal[2], judging from the published accounts of the work done on this disease. Butler reports to have definitely established at Pusa (Bihar) in 1913-14 "the cause of the wilt to be a species of *Fusarium*, successful inoculations with pure cultures of fungus having been secured." The joint authors, Ajrekar and Bal, claim to have isolated two strains of a species of *Fusarium* from wilted cotton plants and to have established their parasitism by inoculation experiments. If these claims can be supported by irrefutable evidence, a great step forward has been achieved towards the solution of this very important problem, since the first real step towards the control of any plant disease is to discover what it is due to. Therefore, it is essential to examine these claims critically to see how far they are justified. Unfortunately, Butler's discovery of the parasitic fungus has not so far been supported by an account of the work done by him. However, Ajrekar and Bal have given details of their work and so we can examine their claim critically.

In the middle of July of 1920, 11 seedlings of Roseum in one pot and 9 in another, the seedlings being about three weeks old, were inoculated with the fungus (Strain I) which they had isolated

[1] Butler, E. J. *Rept. Agri. Res. Inst., Pusa*, 1913-14, p. 55.

[2] Ajrekar, S. L., and Bal, D. V. Observations on the wilt disease of cotton in the Central Provinces. *Agri. Journ., Ind.*, XVI, pp. 598-617.

roots of wilted cotton plants collected from the Agricultural College Farm at Nagpur in 1919 (Experiment No. 1). The result was that 2 out of the 11 seedlings and 4 out of the 9 seedlings inoculated died between the third week of August and the middle of September, i.e., out of 20 Roseum seedlings inoculated only 6 died. Three weeks old Roseum seedlings on the 20th of July were inoculated with the fungus (Strain II) obtained from wilted plants from the pot culture experiments of the Agricultural Chemist, Nagpur, and only one plant died a month later (Experiment No. 3). Two days later, i.e., on the 22nd of July, 5 more seedlings, three weeks old, were inoculated with this fungus. In 3 of these seedlings, the fungus was introduced in the tissues through a puncture made by a needle in the part of the stem in contact with the soil. In spite of this heroic measure the seedlings remained healthy (Experiment No. 4). In the first week of August, 18 Roseum seeds were sown in two pots along with the fungus (Strain II). Healthy plants were raised from these seeds. As a result of these experiments the joint authors claim that two strains of *Fusarium* species have been isolated from wilted cotton plants and their causal connections with the wilt disease established. No explanation is given as to why in Experiment No. 1, Pot No. 1, 9 plants out of 11 escaped the wilt, and in Pot No. 2, 5 plants out of 9 remained healthy. Out of the four plants wilted we are told the original fungus was recovered from three plants, so evidently the fungus was not recovered from the fourth plant, i.e., the cause of the wilt may not be due to this fungus. As no mention is made as to whether the fungus was recovered from the dead plants of Pot No. 1, we do not know if they failed to get the fungus or that they made no attempts to reisolate it.

They attribute the negative results obtained in their other experiments with the Strains I and II "perhaps to the time at which the inoculations were made, the season having advanced by that time." This explanation cannot bear close scrutiny. Their Experiment No. 4, which gave negative results, was made two days after the Experiment No. 2 which gave one wilted plant out of 5 inoculated, even though in Experiment No. 4, as already stated, three weeks old seedlings were inoculated through punctures.

Again, if we admit that plants raised from seeds sown in the end of August along with the fungus remained healthy because the season was too far advanced for the fungus to attack the plants, how can we correlate this with the observations made over and over again that in the fields plants continue to get wilted at all stages of their growth, right up to the end of the season? The joint authors boldly assert that the negative results do not prove anything. In fact the writer of this note believes that these negative results are of great importance. It is evident from the conclusions arrived at by Ajrekar and Bal and from the half-hearted explanations offered for explaining away the negative results, that they started with the fixed idea that the disease was of fungal origin and that the fungus was a species of *Fusarium*.

I have isolated species of *Fusarium* from innumerable wilted plants and from various localities such as Nagpur, Akola, Basim, Murtizapur, Boregaon and Yeotmal, and have made several inoculations under varying conditions, but the results have always been the same and very much similar to those of Ajrekar and Bal, viz., that the fungus failed to inoculate the plants. The more the inoculated plants were under normal conditions the more complete was the failure to inoculate even the most susceptible varieties like AK2 and Roseum. A short account of the inoculation experiments would not be out of place here.

Seeds of AK2, AK4 and Roseum were externally sterilized with corrosive sublimate or strong sulphuric acid, and were planted in sterilized calcium chloride towers and in long test tubes containing sterilized moist sand. When the seedlings were about a week old, they were inoculated with different strains of the fungus isolated from plants from different localities. The inoculum was observed to put forth new growth; but the seedlings remained healthy and there was not even any penetration of the hyphæ in the tissues of the seedlings, till when after several days both the inoculated seedlings and the control seedlings began to show loss of vitality and evident signs of starvation and water-logging; the fungus then made headway in the tissue of the seedlings but even then there was no wilting; there was a wet rot, the internal appearance of the infected tissues was

entirely unlike that of the typically wilted plant. The isolation of the fungus identical with the one used for inoculations from these rotting seedlings cannot be put forward as an evidence of parasitism of the fungus.

The strains that were used for inoculating seedlings under aseptic conditions were used for inoculating plants of AK2 grown in pots containing virgin soil from a tank near Nagpur. The inoculations were done at various stages in the development of the growth of the plants. The following method was used to inoculate the plants; the soil was scraped an inch or two deep. round the plants; the upper lateral roots were cut but the tap root was not injured; the whole contents of a nutrient agar tube in which the fungus was growing luxuriously were transferred to the scraped soil; precautions were taken to have some inoculum attached to the exposed subterranean part of the stem and lateral broken roots before they were covered over again with earth. In every case the result was the same; the controls and the inoculated plants were equally healthy and developed good flowers and bolls.

Plants of AK2. AK4 and Roseum grown in sand in small pots and kept out in the open in a wire cage were similarly inoculated. The inoculations gave uniformly negative results. However, some interesting observations were recorded. For example. plants in pots brought to the laboratory began to droop if kept there even less than half an hour before replacing them in the wire cage. Even the next day they looked sickly. The leaves ultimately dropped. the plants did not die but their growth was stunted. Again it was found that the parts of the plants which came in contact with the inner walls of the bell-jar used for covering inoculated and control plants turned brown and drooped and ultimately did not recover. Further, it was observed that if the tap root was injured the plant began to dry up immediately and developed typical external symptoms of wilt but not the internal. There was no browning of the inner tissues. It is possible, therefore, that inoculations carried out under such or similar conditions may at times give what may be mistaken as positive results especially if the inoculated plant has had a severe set-back.

Thus we see that as yet nó conclusive evidence has been produced to prove the fungal origin of the cotton wilt.

The question then naturally arises what is the nature of the wilt and if the fungus which has been found in wilted plants which have been collected in various localities such as Nagpur, Basim, Akola, Murtizapur and Boregaon, has any connection with the wilt. This question may perhaps be answered by a careful examination of the diseased tissues.

The internal appearance of a wilted plant is very characteristic. In the early stages of the attack the effect on the tissues is a yellowing of the walls of some of the vessels, these walls then turn deep yellow brown, ultimately dark brown and then quite black: at times the vessels are filled, partially or wholly, with some dark coloured substance. The vessels of affected tissues have these colours even when they do not contain any mycelium. In fact the vessels in which the hyphae are found may be otherwise quite normal in appearance. The mycelium has been very seldom found in such large quantities as to plug the lumen of the vessels. Even Ajrekar and Bal, who claim to have discovered the parasitic fungus, have not failed to observe that the mechanical blocking up of the vessels was not so complete as to account for the wilting effect and therefore they suspected that the fungus secreted some toxin which brought about the death, but they failed to verify the suspicion by their experiments. It is remarkable indeed that the plant should so completely wilt even though the fungus could be traced only in a few vessels and even these were, at best, only partially clogged. If healthy plants and wilting plants are placed in tap water coloured with methyl blue, all the vascular tissues of the healthy plants are found to be functional as evidenced from the presence of blue colour in these tissues; but in the wilting plants a number of the vascular strands are found not to function. If the tissues from a wilting plant are boiled in a concentrated solution of logwood containing ammonium carbonate, the sections from a diseased plant and from a healthy plant show a characteristic difference. The tissues from the healthy plant stain pink, but in the diseased tissues of the wilting plant not only the walls of some

tissues are coloured blue and not pink but some of the cells contain varying amounts of dark blue deposits. These deposits are found not only in the lumen of the vessels and cells of vascular strands but also in cell lumen of the medullary rays, endodermis, softer tissues of the phloem and in the cortex. In many cases the cell cavities are completely filled with this substance which is not visible till it is stained blue or dark blue with logwood and amonium carbonate. Again if bits of the diseased tissues, untouched by a steel knife, are placed in an acidulated solution of potassium sulpho-cyanide, they take pink or red colour. No wilting or wilted plant has been found up to now, which has not invariably given either both or one of these two reactions, especially the blue reaction with logwood and ammonium carbonate; these are micro-chemical tests for aluminium and iron. The fungus mycelium has invariably been found only in the plants in the tissues of which the accumulation of these salts has been ascertained by these micro-chemical tests. Attempts were then made to find if these substances were to be found in the tissues of the plants without the fungus. It has already been stated that normally healthy plants did not give the reactions described above. In wilted areas and in pots containing soil from wilted fields a search was made for plants in the early stages of wilt, showing either the presence of the fungus without these salts or of the salts without the fungus. Up to now no plant has been found to show the presence of only the fungus hyphæ in the tissues without these accumulations of aluminium and iron salts, but plants have been found which have shown the presence of the salts of aluminium and iron in their tissues, by micro-chemical tests, in absence of the fungus. These tests have also been tried with the tissues of cotton plants attacked by *Rhizoctonia solani* Kunz in C. P. and Madras (the Madras specimens were obtained through the courtesy of Mr. Hilson); but they have given the same reactions as the healthy tissues; thus we see that these reactions are peculiar only to plants suffering from wilt.

When inoculation experiments with the fungus isolated from wilted plants failed to infect healthy plants, experiments were made to inject one per cent. solutions of salts of aluminium and

iron in the tissues of healthy plants growing in three feet high pots filled with virgin soil from a lake near Nagpur. The plants were over four feet high, the stem about 10 mm. in diameter and had lovely green foliage. The injections were made by introducing a fine capillary end of a bent glass tube, about 10 mm. in diameter, in the stem near the ground level. In no case was the plant given more than 10 c.c. of the solution, but it is extremely improbable that all this quantity was absorbed by the plant because the injections had to be given to plants growing out in the open; and on account of exposure to strong wind and rain the water-tight connection between the injecting tube and the plant was displaced more often than not. Whether the plant was injected with aluminium chloride or aluminium sulphate or with ferric chloride or ferrous sulphate the appearance of the tissues was the same. Where the connection between the injecting tube and the stem had remained water-tight sufficiently long, it was found that the central tissues had become black and a part of the surrounding tissues had turned brown for a distance of about eight inches above the point of injection and in some cases also a few inches below ground level. Microscopical appearance of sections cut from the part of the stem which had absorbed the solutions was identical with that of the diseased tissues of a wilting plant. Plants injected with aluminium salts gave positive reaction with logwood and ammonium carbonate and negative reaction with potassium sulpho-cyanide. Plants injected with iron salts gave positive reaction with potassium sulpho-cyanide and negative with logwood and ammonium carbonate. Along with the injections of these salts pure distilled water was also injected in some plants which served as controls. The internal tissues remained normal and gave no micro-chemical tests for aluminium and iron salts. The external effect of the injection of salt solutions was drying up of two or three leaves above the point of injection. None of the injected plants completely wilted though one or two plants showed signs of wilting the day following the injection but they soon recovered. It is probable that sufficient quantity of the solutions was not absorbed by the plant to cause wilting; besides the tissues which had absorbed these solutions and had thereby ceased to

function, there were a large number of vessels and cells which were normal and functional. This may be the reason why there was no wilting of the injected plants. And this explanation seems to be borne out by observations made at the Nagpur Farm on the wilted plots in the middle of November and from the pot culture experiments. On the experimental plot most of the Roseum and AK2 plants had completely wilted but there were a few plants which looked healthy. But in cutting open the stems of these plants it was found that the majority of these plants showed a certain amount of browning in the vascular tissues. The sections had the same microscopic appearance as the diseased tissues of wilted plants. The fungus hyphæ were present in the vessels not in any conspicuously marked extent less than in the wilting plants. The micro-chemical tests showed that aluminium and iron had not accumulated in all the tissues. The accumulation of these salts was not general but rather scattered. The majority of the cells and vessels were functional and perhaps therefore the plants did not show signs of wilting. It is not possible to say if these plants would have wilted if they had been allowed to stand longer in the ground. The few surviving plants in pots containing "wilted" soil which externally looked healthy, though small in size, in the middle of November, also showed the characteristic browning of some of the tissues and gave positive reactions for aluminium and iron, though the fungus mycelium was not observed in all these plants.

AK2 plants grown in pots containing sand were carefully removed without injuring the tap roots and were transplanted to jars containing distilled water and different concentrations of the normal solution of aluminium chloride, viz., 0·01 per cent., 0·005 per cent. and 0·0001 per cent. The jars were covered with brown paper and were kept out in the open. All the plants at first drooped and shed their leaves. New shoots and leaves were put forth by all the plants except those kept in 0·01 per cent. normal solution. This concentration of the salt was found to be toxic. These plants wilted and were dead in a week. On cutting open the plants it was observed that there was the typical browning of the vascular strands commencing from top downwards. Sections of

the upper portions of the plants were typical of the normally wilted plants. There was the yellowing of some of the vessels. In sections from the lower portions of the stem and roots, discoloration of the vessels was absent. Sections when boiled in logwood solution containing ammonium carbonate gave typical reaction of wilted plant. Not only were the cell walls, especially of the vascular strands, coloured blue but many of the cells and vessels were plugged with a dark blue deposit. This plugging of the lumen was not visible in the unstained sections.

The constant accumulation of the compounds of iron and aluminium in the tissues of wilting plants, the constant absence of these accumulations from the tissues of healthy plants and plants attacked by *Rhizoctonia solani* Kunz and the complete failure to isolate a parasitic organism from the wilting plants, suggest that the accumulation of these compounds may have some correlation with the wilt and that the species of *Fusarium* which has been isolated from wilting plants in different cotton tracts may be merely a contributory factor in hastening the death of the plant and that the fungus follows in the wake of the accumulations of these compounds in the tissues.

I wish to take this opportunity to thank my colleagues, the Agricultural Chemists, Mr. F. J. Plymen and Mr. A. R. Padmanabha Aiyer, the Principal of the Agricultural College, Mr. R. G. Allan, and the Economic Botanist, Mr. W. Youngman, for the help they have given to me in my work.

THIRTEENTH MEETING OF THE BOARD OF AGRICULTURE IN INDIA.

BY

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THE Thirteenth Meeting of the Board of Agriculture in India was held at Bangalore in the Daly Memorial Hall from 21st to 25th January, 1924.

His Highness the Maharaja of Mysore evinced his deep interest in the deliberations of the Board by graciously consenting to preside at its opening meeting. His Highness, who was accompanied by Their Excellencies the Resident and the Dewan and other high officials and notables of the State, in opening the proceedings said that it gave him peculiar pleasure to welcome the Board to Mysore because it was the first occasion on which the Board had met in an Indian State. Referring to the agenda His Highness said that the questions down for discussion gave but a faint impression of the magnitude and complexity of the problems which confronted the department. His Highness saw, in the development of agricultural co-operation, the means whereby the department would be freed from the work of retailing and distributing agricultural necessities, and he hoped that the results of the Board's deliberations on the subject would enable Local Governments to deal with the question more effectually than they had been able to do in the past.

Dealing with the question of cattle improvement, His Highness said that work on scientific lines had barely begun. It was necessary to lay, at the beginning, broad and sound foundations. A sound policy and a firm determination on the part of Local Governments and Agricultural Departments to carry out that policy till results were achieved, were essential to success.

Discussing the question whether or not experimental farms should be self-supporting, His Highness was of the opinion that the expectation that these institutions should be made to pay had arisen from a misunderstanding of the functions of these farms. They were really outdoor laboratories for the investigation of problems connected with the agriculture of a particular area, and as such were on the same basis as laboratories maintained by large manufacturing concerns to investigate manufacturing and other problems. No industrial concern would expect its scientific laboratories to be self-supporting, and in the same way it appeared to be extremely unwise and short-sighted to lay emphasis upon the money-making side of the experimental farm. A better criterion of its usefulness was the influence it exerted on the agriculture of the State. At the same time it was reasonable to expect that funds should be expended as economically as was consistent with sound work.

In conclusion, His Highness paid a tribute to the excellent work being done by the Mysore Department of Agriculture under the guidance of its present experienced head, Dr. Leslie Coleman, and to the real progress which had been made in all parts of India since the Board first met 19 years ago. The immense distance which lay between Indian agriculture in its present state and Indian agriculture as it should be, called for the most strenuous efforts the department could put forward and for the most loyal support and recognition of the department's work on the part of Local Governments.

In his reply to the address of H. H. the Maharaja of Mysore, Mr. S. Milligan, President of the Board, expressed the appreciation of the members of the Board of His Highness's kindness in inviting them to hold their biennial meeting in Mysore. Not only was this the first occasion on which the Board had met in an Indian State; it was also the first occasion in the history of the Board on which a Ruling Prince had consented to preside at its opening meeting. The occasion was unique and, if he might say so, inspiring. Mysore was justly proud of its position among Indian States not only in respect of its agricultural development but also of the rapid strides it had made along other lines of advance—social, economic and

scientific. It was a well-known fact that the prosperity of the State was due in no small measure to the incessant and unsparing efforts of its highly enlightened and sympathetic ruler. He was sure that the words of encouragement His Highness had been kind enough to say would prove an incentive to further work not only in Mysore but throughout India.

Continuing, Mr. Milligan said that the Board had been associated with the work of the Agricultural Department in India since its reorganization nineteen years ago. It had been of extraordinary value in the development of the Imperial and Provincial Departments in that it had succeeded in preserving a wide outlook amongst workers in the provinces and had been the means of promoting collaboration, unity of purpose, and standardization of agricultural education throughout India, to a degree which would otherwise have been impossible. Since they last met, the Agricultural Department as a whole had had a very anxious time owing to the financial situation which appeared to have a tendency to become chronic. Although the current activities of the department had not been affected to any considerable extent, financial stringency had unfortunately stood in the way of the development which had been so seriously delayed during the war. Recruitment of experts to existing vacancies had been limited and there were still no fewer than 41 vacancies in the Imperial Service.

Financial considerations had made it impossible to proceed with the scheme for the provision of post-graduate training to qualify Indians for admission to the Imperial Service. A beginning had, however, been made in providing post-graduate training in sciences allied to agriculture, including animal husbandry and dairying, and a similar training for veterinary officers had been arranged for, as an experimental measure, at Muktesar. Another important development was the transfer of Bangalore, Wellington and Karnal dairy and cattle-breeding farms from the Military to the Agricultural Department with a view to provide experimental and educational facilities. A dairy manager's course had been started in Bangalore which would qualify students for the "Indian Diploma in Dairying."

Before introducing the items on the agenda, the President made sympathetic reference to the losses which the department had suffered in the deaths of Mr. Petty, Mr. Henry and Thakur Mahadeo Singh, all in the prime of life and of much promise. He desired the Board to formally express its sympathy with their relatives. The proposal was carried in silence, all members standing.

In conclusion, the President informed the meeting that the Hon'ble Sir Narasimha Sarma, Mr. M. S. D. Butler, and Mr. Grantham had asked him to express their deep regrets at their inability to attend.

After appointment of Committees to deal with the various subjects, the Board proceeded to the consideration of *Subject I—To consider the progress made in giving effect to the recommendations of the Indian Cotton Committee for* 1917-18 *with special reference to* (*a*) *the work of the Central Cotton Committee*; (*b*) *the recommendations of the Board of Agriculture of* 1919 *in regard to cotton marketing.*

Mr. Burt, Secretary of the Central Cotton Committee, on being invited by the President to give a short sketch of the work of the Committee, said that their annual report showed that the recommendations of the original Indian Cotton Committee had been amply justified. They had now an unique organization on which all sections of the cotton industry were represented. They had funds raised by the industry for its own improvement provided by the cotton cess, and had been able to start a well-balanced research programme with the feeling that it was adequately financed. The results already achieved were due, in a very great measure, to the whole-hearted support of all sections of the cotton trade. Their policy in regard to agricultural research was to make funds available for special investigations and, wherever possible, to supplement the work of the Provincial Departments. The Technical Research Laboratory under Prof. Turner would, they considered, be of special value to cotton-breeders in their work on new cottons.

Steps were being taken to prevent the introduction of the boll weevil from America into India. The Government of India had provisionally accepted the Committee's proposal that the

Pests Act should be put into force, that all American cotton should be fumigated on arrival in India, and that Bombay should be the only port of landing.

The improvement of cotton marketing was a separate subject. The Cotton Transport Act had been passed by the Indian Legislature and was now in force in practically the whole of the staple-growing parts of the Bombay Presidency and would soon, it was hoped, be brought into force in Madras and the Central Provinces.

Recommendations for the regulation of gins and presses, embodying provisions which would enable Provincial Governments to introduce a system of licensing, were still before the Government of India, but they had every reason to expect legislation at an early date. When that was done, they would feel that two outstanding abuses which not only caused considerable inconvenience and annoyance to the cotton trade, but also very serious economic loss to the cotton-grower, would be considerably reduced.

Dealing with the question of cotton marketing, Mr. Burt said that the Central Cotton Committee had practically adopted the recommendations of the Board. They had submitted draft rules for the working of markets on lines similar to those in Berar. Their recommendations went further than the practice in Berar in that definite provision had been made that half the members of the market committee should be representatives of the cotton-growers of the area served by the market.

Mr. Burt invited the opinion of the Board on the question of the publication of cotton prices. The point at issue was whether Bombay prices per *khandi* of ginned cotton should be posted or whether *kapas* prices should be notified. A possible method would be to convert, not the prices of ginned cotton but the differences, into terms of *kapas*, e.g., Rs. 5 per *khandi* in Bombay might correspond to a rise of, say, 3 annas per maund of *kapas* in the local market. The ensuing discussion brought out some differences of opinion, but the majority were in favour of publishing lint prices and, at the same time, indicating the extent of the rise and fall of the market by the method suggested by Mr. Burt.

In a discussion on the operation of the Cotton Transport Act, Dr. Mann said that many unforeseen difficulties had arisen. Two points he considered to be essential; one was that small areas should be avoided. Such areas had caused difficulties in the Bombay Presidency and would probably necessitate modifications in the notification in the near future. Secondly, it was essential to deal with road transport which he considered to be the key of the situation.

The Board then proceeded to discuss *Subject II—The utilization of indigenous supplies of phosphates.*

The President said that the question had been referred to a Committee of the Board in 1917. After considering the report of the Committee that Board recorded the opinion that a survey of the resources of the country in mineral phosphates should be undertaken by Government and that Government should maintain control over all the internal mineral sources of supply.

The supplies of phosphatic manures in India consisted of raw mineral rock, bones and fish manures. Nothing had so far been done to develop the supplies of rock phosphates. The supply of fish guano varied with the nature of the fishing season. Bones were, therefore, probably the most important phosphatic manure in India at present. The question of restriction on the export of bones had been considered by the last Board which was of opinion that it was doubtful whether restriction would achieve the end desired, but the Board had requested the Government of India to form a Committee to consider the question of the retention of the manurial resources of the country and to suggest a constructive policy to that end. The Committee proposed had not been appointed.

Mr. Hutchinson referred to the article published by him in the January 1924 issue of the "Agricultural Journal of India" on the possibility of making mineral phosphates available by natural bacterial processes. He did not know how far the process was applicable to bones, but the indications were that the process would be just as applicable to bones as to mineral phosphates.

Mr. Anstead pointed out that Mr. Hutchinson's work and their own had shown that indigenous phosphates could be used in India,

and particularly in Madras, but the great difficulty was the cost. In Madras fish guano and bone dust were being sold to firms for outside export, and phosphates were being utilized for mixing with other manures for export. He thought that deposits, such as the important one at Trichy, should be looked upon as the property of the State. In reply to a question on the extent to which export was depleting the supply, he said that no reliable figures were available. The main consideration was that the supply was limited.

Other members spoke on the benefit of phosphatic dressings on various crops. It was finally resolved—

That Government be asked to give immediate effect to the recommendation of the 1922 Board with reference to the appointment of a Committee to investigate the economic position of indigenous fertilizers in India, and to formulate a definite constructive policy to ensure their use for the benefit of the Indian ryot.

That in the opinion of this Board, the utilization of indigenous phosphates in India would be facilitated by local investigation of the method of bacteriological solubilization by sulphur-oxidizing bacteria, and this method should, therefore, receive the particular attention of the expert staff of the various Agricultural Departments, which should, if necessary, be strengthened for that purpose.

The second and third days were devoted to the consideration, by the several Committees, of the subjects with which they had been appointed to deal and to the drafting of their reports.

The Board reassembled on the fourth day when the following resolution was unanimously adopted :—

That the Board desires to express its satisfaction that so many of the recommendations of the Indian Cotton Committee, 1917-18, and of the Board of Agriculture, 1919, have been given effect to. In particular, it desires to place on record its appreciation of the support which the Central Cotton Committee has received from all sections of the cotton trade. The Committee has already achieved important results and this is due in a large measure to the serious way in which commercial men of standing have given their time and thought to the work of the Committee.

The Board then proceeded to consider the report of the Committee appointed *To review the progress made in non-credit agricultural co-operation in India and to consider ways and means of stimulating further progress* (*Subject III*).

Dr. Mann, in presenting the report, said that the subject referred to was an exceedingly wide one and one that would become of increasing importance in the future. Hence the Committee had been able to deal with only one or two aspects of it. The

first part of the report dealt with the relationship between ordinary agricultural propaganda and the utilization of co-operation for bringing that knowledge into general use. There had been a big hiatus in the past between demonstration and actual practice, and the Committee thought that the best method of bridging the hiatus was to organize bodies of cultivators into co-operative societies. The Committee recognized that it was in co-operation with the Co-operative Department and with co-operators generally that the extension and general adoption of agricultural improvements had its greatest chance. Paragraph 6 of the report went further in that it suggested that the staff to be utilized should be combined agricultural and co-operative; whether the propaganda should be directed and controlled by the Agricultural Department or by the Co-operative Department was a matter on which the Committee had been unable to agree, and which seemed to depend on the varying conditions obtaining in the different provinces.

Referring to the second part of the report which dealt with co-operative sale, Dr. Mann said that the Committee had advanced certain proved principles on which co-operative sale was most likely to succeed. One was that large sale units must be dealt with so as to enable a society to exert a perceptible influence over the whole trade in a particular commodity in a given area, thereby securing to the society the best terms possible. Again it was necessary to realize that amateur management was useless in enterprises involving difficult commercial transactions. Co-operative sale was an intricate and delicate business and must be developed under expert professional management. Further, the Committee emphasized the necessity of a definite economic advantage to the members of the society from the beginning. Co-operative purchase, too, was very largely conditioned by the same considerations which had been mentioned in connection with co-operative sale.

The Committee had considered other forms of non-credit co-operation but had not been able to make any recommendation with regard to them. They recommended further examination of the whole subject at the next meeting of the Board in the light of the additional information which would then be available. In

particular, the Committee would draw attention to the work being done in the Punjab by Land Consolidation Societies.

After a long discussion, which dealt mainly with paragraph 6 of the Committee's report, the President said that the divergence of views would seem to justify the inclusion of that paragraph in the report, and that on the whole the paragraph, as it stood, might be taken to express the views of the Board. The report of the Committee was adopted unanimously, as was a resolution to the effect that—

The Board recognizes the fundamental importance to agriculture of the work on consolidation of holdings that is being carried out under the influence of the Co-operative Department in the Punjab, and wishes to bring the fact prominently to the notice of Local Governments.

The report of the Committee on *Subject IV—Is it possible and desirable to make Government farms, including experimental, cattle-breeding, seed and demonstration farms, pay?* was introduced by Dr. Clouston. The subject, he said, was a very important one inasmuch as it had been the basis of a great deal of uninformed criticism on the part of Provincial Councils.

Mr. Henderson agreed that the subject was important, not only on account of the existing farms, but also from the fact that all new schemes were liable to be considered from a financial aspect only. This might prove a great hindrance in the many special investigations which had to be carried out from time to time.

The following resolution was carried unanimously:—

This Board is of the opinion that the essential factor in the working of a Government agricultural station is the fulfilment of the specific object or objects for which the station is established. While realizing that the station should be managed as economically as possible, the Board is of opinion that the financial aspect is of entirely secondary importance and should not be allowed to interfere with the object or objects of the station.

Mr. Burt presented the Report of the Committee appointed to deal with *Subject V—To consider the steps taken to give effect to the recommendations of the Board of Agriculture of* 1919 *for the improvement of (a) forecasts, (b) final statistics of the area and yield of crops in India.*

The Committee proposed the following resolutions for the consideration of the Board and these, after discussion, were adopted unanimously:—

The Board regrets that not only have many of the recommendations of the Board of Agriculture of 1919 not been given effect to, but that on the contrary reduction of statistical staffs

and of compilation has made the preparation of reliable crop forecasts more difficult than before. They desire to emphasize the importance to the country of accurate agricultural statistics and of proper forecasts for the major crops.

The Board observes with regret that only in one province does the recommendation of the Board of Agriculture in 1919, that each Director of Agriculture should be provided with a qualified Statistical Assistant, appear to have been adopted. They are strongly of opinion that the appointment of such Statistical Assistants is an absolute necessity if any real improvement is to be made in forecasts.

While every effort should be made to take the fullest possible advantage of trade statistics, it is not possible to obtain from such statistics the figures for the total production from which to calculate the standard outturn per acre. Crop-cutting experiments must remain the basis of such standards.

The standard outturns for various crops now in use have resulted from crop-cutting experiments made over a number of years, verified by such information as has been available from trade statistics. Changes should only be made as a result of crop-cutting experiments sufficiently numerous to possess a definite statistical value. In choosing fields for crop-cutting experiments no attempt should be made to select average fields, but the selection should be made purely mechanically so as to give a statistically random distribution. Changes in the standard yield should not be made as a result of discrepancies brought to light by trade statistics, as such discrepancies occur in the product "condition factor × standard yield," and the fault is most likely to lie in the interpretation of the primary condition reports.

In the opinion of the Board of Agriculture the first step in any attempt to improve statistics should be to appoint a Statistical Assistant under each Director of Agriculture with an adequate staff for the carrying out of crop-cutting experiments on a limited scale with the object of determining how such experiments can best be conducted for the province generally. The organization subsequently required could then be determined.

The Board of Agriculture strongly recommends that the compilation of rail-borne trade statistics should be revived, as these statistics provide for many crops a most important check on the estimates of production in addition to information essential to the study of the economic progress of India.

That this Board endorses the recommendation of the Indian Cotton Committee, the Board of Agriculture 1919, and of the Indian Central Cotton Committee, that weekly returns from all cotton pressing factories of cotton pressed should be made compulsory as early as possible.

That in all cotton-growing provinces a definite effort should be made to obtain a reasonable estimate of the amount of cotton consumed in villages, whether for hand spinning or for domestic purposes. This could probably be done by a detailed statistical study of the information available for individual internal trade blocks. Road-borne trade would also be of importance and the extent of this would necessitate special local enquiry.

The Board then passed to a consideration of the report on *Subject VI*, the terms of reference being, *To consider the recommendations of the Sugar Committee relating to the future of the Coimbatore Sugarcane Breeding Station and to make recommendations.*

Mr. Noyce in presenting the report said that one or two points called for comment. In the first place the sugarcane station must be made an Imperial institution because they were more likely to get the necessary funds from the Central Government than from the Madras Government. The second point was that his Committee did not endorse the view that work on the evolution of

improved varieties of cane for Upper India, which would withstand the indifferent usage of the ordinary cane grower, should be abandoned as impracticable. His Committee thought rather that it should be encouraged. Conditions had changed since the report of the Sugar Committee had been published, and it would be impossible for some years to establish an All-India Sugarcane Research Station. In the meantime they should take things as they were. Coimbatore should be made a breeding centre for the whole of India, and other research work connected with sugarcane should be left with the Provincial Departments concerned.

Several members of the Board gave particulars of the excellent results which had been obtained with Coimbatore varieties in the provinces. The report was adopted and the following resolution passed unanimously :-

This Board supports the recommendations of the Indian Sugar Committee that the Coimbatore Cane-breeding Station and the post of Sugarcane Expert should be made permanent and that the station should be transferred to Imperial control. It further recommends that immediate effect be given to these recommendations. It strongly supports the recommendation of the Sugar Committee that the scope of the station should be enlarged in order to include the breeding of new varieties of thick cane for Peninsular India, Burma and Assam, and considers that the area and staff of the station should be increased immediately for this purpose. In the meantime, every effort should be made to commence work on breeding thick canes with the facilities at present available. It would add that even for work on thin canes an extension of the present area is highly desirable.

Mr. Fletcher then moved a further resolution to the effect that :-

This Board endorses the recommendation, in paragraph 247 of the Report of the Indian Sugar Committee, that the staff of the Imperial Entomologist should be strengthened by the appointment of an additional Entomologist whose principal duty would be the investigation of cane pests. In view of the large recurring losses at present caused by borers and other cane pests, the Board considers it desirable that steps be taken as early as practicable to put this recommendation into effect.

Some years ago, he said, they had thought that sugarcane borers were of one species which could be trapped by growing maize. After investigation, however, he had found that there were quite a number of species but it was impossible for him to proceed further in the investigation which, he considered, required the services of a whole-time officer. Unfortunately no steps had been taken to appoint one.

The resolution was passed unanimously.

On the fifth day the Board took up the discussion of the report on those subjects on the agenda which had been referred to the Cattle Conference (Subjects VII, VIII and IX).

Subject VII was with reference to *the curriculum of the Imperial Institute of Animal Husbandry and Dairying at Bangalore.* Mr. Milligan, who presented the report, said that the Conference had unanimously approved of the institution of an Indian Diploma of Dairying and had agreed to the curriculum drawn up by the Imperial Dairy Expert, but recommended that one extra subject, viz., that of the principles of co-operative dairying, should be taught.

The Conference generally agreed with the *programmes* laid down *for the Pusa, Bangalore, Wellington and Karnal Dairying and Cattle-breeding Farms (Subject VIII).*

At Bangalore it was recommended that the system of breeding towards Ayrshire and Holstein stock should be continued; that a small pure-bred Sindhi breed be maintained; that a small pure Jersey herd be built up; and that a small herd of Murra buffaloes be kept.

For Wellington the Conference suggested that, in addition to breeding towards Ayrshire and Holstein stock, a few thoroughbred Ayrshires should be imported and an attempt made to produce pedigreed Ayrshire cattle there.

The development of a pure herd of Thar-Parkar cattle at Karnal on dual-purpose lines was approved, as was the crossing of a number of Thar-Parkars with European blood for experimental purposes. A small herd of pure-bred Jerseys would be maintained to test their ability to stand climatic conditions. It was further recommended that the development of the Hariana breed on dual-purpose lines should be undertaken.

It was agreed that the pure Montgomery herd at Pusa should be maintained and developed; that further selective breeding should be done in connection with cross-crosses; that cross-breeding experiments should be maintained; and that half-bred Ayrshire-Saniwal cows should be sired by a first class Montgomery bull of milking strain with a view to maintaining the milking qualities of the half-bred and restoring the immunity to disease of the Saniwal.

With reference to *Subject IX—A review of the steps being taken by Provincial Governments towards the improvement of cattle*—Mr. Milligan said that they had made a very detailed examination of the cattle-breeding programmes of the various provinces and Indian States and their report was on the whole simply a confirmation of the programmes submitted. They considered most of the schemes to be on sound lines, the main object being improvement of the local breeds for dual purposes. But at the same time the Conference considered that nothing like the amount of time and money was being spent on the subject that it deserved.

Before the formal moving of the adoption of the report of the Cattle Conference on Subjects VII, VIII and IX, three resolutions were proposed as follows and carried unanimously:—

This Board wishes to emphasize the fundamental importance of the work on animal nutrition which is being done by the Imperial Physiological Chemist. It desires to impress upon Local Governments and Departments of Agriculture the absolute necessity of co-operation with the Imperial Physiological Chemist in his work.

This Board expresses its appreciation of the value of the work done by the Military Dairy Department in preserving and grading up the Sahiwal breed of milch cattle and desires to thank that department for its assistance and co-operation, more especially in handing over, for the use of the cattle-breeding operations, the farms at Bangalore, Karnal and Wellington, and trusts that if at any future date the dispersal of any pedigree herds is contemplated the Agricultural Department may be given the first offer of taking over the herds as a whole.

The Board wishes to bring to the notice of the Government of Bihar and Orissa the value of the results achieved in other provinces—particularly in the Punjab and Bombay—by the definition and improvement of popular types of cattle through the establishment of breeding herds. The position of Bihar as the chief breeding ground for cattle imported by Bengal seems to guarantee that similar work in that province, besides raising the value of the local cattle for the cultivators' own use, would greatly increase the value of an already important and profitable trade.

The Board then returned to the report of the Cattle Conference. The Conference had not only discussed the items referred to it from the agenda of the Board, but it had its own provisional programme in addition. The question then arose whether those further items, included in the report of the Conference, should be incorporated in the proceedings of the Board. A long discussion ensued, the main point at issue being a recommendation of the Conference with reference to the encouragement of fodder cultivation by means of water and revenue concessions. It was finally resolved—

That this Board adopts the report on Subjects VII, VIII and IX of the Cattle Conference.

The Board supports the following recommendations of the Cattle Conference:—(1) That in future a Conference on similar lines and of similar composition and size to this be held yearly at centres to be agreed upon, the place of meeting to be selected by each Conference for its succeeding meeting. The Conference further recommends that the necessity for providing facilities to enable all officers interested to attend this Conference be impressed upon all Local Governments and Indian States.

(2) That a Central Bureau of Animal Husbandry be established at Pusa under the control of the Agricultural Adviser to the Government of India and with the Imperial Agriculturist as Secretary, and that the Secretary be given sufficient technical and clerical assistance to adequately deal with the work of this Bureau as it develops. The main functions of this Bureau to commence with would be:—

(*a*) The collection and dissemination of information concerning cattle breeding and allied subjects.

(*b*) To assist in the disposal of surplus pedigreed stock specially from Government farms.

(*c*) The standardizing of methods of milk recording and breed records to be adopted by Local Governments and Indian States.

(*d*) The maintaining of general herd books of breeds, or of milch cattle as distinct from specific breeds, found in more than one province or State.

(*e*) The encouragement of the sale and use of pedigreed stock.

(*f*) The keeping of the cattle breeding departments of Local Governments and Indian States, and those specially interested in scientific cattle-breeding, in touch with each other.

Subject X—To review the progress in the use of improved implements and to make recommendations—had been referred to a Committee, but the Chairman expressed regret that, owing to the paucity of information at their disposal, his Committee had been unable to submit a report. It was ultimately resolved—

That every effort should be made to collect all reviews on the progress made along the lines of the terms of reference from all the provinces and Indian States and that a Bulletin embodying the information contained in these reviews be published by the Agricultural Adviser to the Government of India.

The last *Subject XI—The desirability of bringing waste lands under cultivation*—was then taken up by the full Board. The discussion brought out the conditions under which land was allowed to lie waste. These were bad communications, fragmentation of holdings, scanty rainfall combined with light soil, insufficient labour supply, the effect of the famine and, in the Punjab in particular, the disinclination of the ryot to cultivate more than a given area. The remedies suggested were: loans by co-operative societies to cultivators who lacked the means to break up the land: consolidation of holdings; the evolving of early-ripening varieties of crops for areas of light rainfall; introduction of improved ploughs which would in some measure counteract the scarcity of labour;

and the use of tractors and heavy ploughs to break up land which had become infested with deep-rooted weeds.

Before the proceedings terminated, the following resolution was adopted unanimously: —

The Board desires to express its grateful thanks to His Highness the Maharaja of Mysore for the interest he has taken in its proceedings and for the hospitality he has been good enough to extend to it in Bangalore and Mysore. It also desires to express to Dr. Coleman and the officers of the Mysore State its high appreciation of the excellence of the arrangements made for the meeting of the Board.

The President in his closing speech reviewed the progress the Board had made since its inception, and paid a tribute to the valuable assistance it had received from the large number of experienced officers of other departments who had assisted at its deliberations from time to time. This was the last Board which he would attend; he thanked them all for the tolerance and ungrudging help he had always been accorded.

Col. Walker, in proposing a vote of thanks to the President, wished him all success in his future career. They all appreciated his sterling qualities and the splendid work he had achieved in India.

By the courtesy and hospitality of His Highness the Maharaja of Mysore, the members of the Board were given an opportunity, before dispersing, of visiting the capital of the State. The guests proceeded to Mysore by special train on the evening of the 25th and every arrangement was made for their comfort during their visit. Among other places of interest visited on the 26th were the Palace, the Palace Dairy, the Silk Farm and the Krishnaraja Sagar Works.

AN IMPROVED METHOD OF LUCERNE CULTIVATION, II.

BY

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Imperial Economic Botanist.

At the previous meeting of the Indian Science Congress (Lucknow, 1923) an improved method of lucerne cultivation, suitable for alluvial soils, was described.[1] This consists in growing the crop on flat beds, two feet wide, with irrigation channels, one foot wide, between the beds. These channels act as drains during the monsoon and help to maintain the aeration of the soil of the beds. The seed is sown on the beds and in the irrigation channels, so that the stand appears to be continuous and no bare ground is visible. In the rains, the plants in the trenches die out. By this system, high yields are obtained, the texture of the soil is preserved, the amount of irrigation water needed is substantially reduced while weeds give little trouble. A plot, sown on October 20, 1921, gave eight cuts up to July 11, 1922, at the rate of 70,000 lb. of green fodder to the acre.

In October 1922, an experiment was begun at Pusa in order to compare the growth of lucerne on the ridge and on the flat bed system. The plots were one quarter of an acre in area and were in duplicate. The lucerne was sown on October 22, 1922, after green manuring with *sanai* (*Crotalaria juncea* L.) and oil cake, at the rate of ten maunds to the acre, was applied some time before sowing. Higher yields would probably have been obtained if the soil had been richer. The crop on the ridges and on the beds was

* A paper read before the Agricultural Section, Indian Science Congress, 1924.

[1] *Bulletin* 150, *Agri. Res. Inst., Pusa*, 1923.

very uniform, that in the trenches, which was sown too late, was poor. This materially reduced the total yield. The hot weather of 1923 was not at all severe while the rainfall was only 28·37 inches compared with the Pusa average of 47·5 inches. These circumstances greatly favoured the crop on the ridges which, in normal years, dies out during the hot months of April and May. The number of cuts was eleven and the yields are given in Table I.

TABLE I.

The yield of lucerne on flat beds and ridges at Pusa.

First cut Dec. 17 1922	Second cut Jan. 25 1923	Third cut Feb. 28 1923	Fourth cut Mar. 28 1923	Fifth cut May 5 1923	Sixth cut May 24 1923	Seventh cut June 16 1923	Eighth cut July 12 1923	Ninth cut Aug. 7 1923	Tenth cut Sept. 7 1923	Elev cu Oct 19
m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m.
10 8·5	18 23	21 9	18 13	18 23	15 39	11 23	10 5	10 4	7 0	5
17 27·5	25 23	24 31	19 33	21 22	14 33	10 10	10 28	13 35	9 34	3
12 35	19 35	21 14	19 26	20 1	15 26	13 9	12 28	14 38	9 36	7
20 28	26 19	25 17	19 3	17 15	14 10	13 19	13 32	17 31	11 22·5	6
61 19	90 20	92 31	76 35	77 21	60 28	48 21	47 13	56 28	38 12·5	23

It will be seen from the figures that good cuts were obtained from December till August after which a rapid falling off in growth took place. The second half of the rains is the period when the Pusa soil loses its permeability. The pore spaces become water-logged and soil aeration is difficult. Although the season favoured the ridges and the irrigation trenches did not bear a full crop, the total yield of the beds exceeded that of the ridges by 44 maunds, over ten per cent.

The great advantage of the beds over the ridges lies in the saving of water. In the experiment, the irrigation water used was not measured directly but was determined by noting the time taken—the pumping engine being worked as uniformly as possible during each watering. Between October 23, 1922, and June 11, 1923,

the plots were irrigated twenty-one times. The total time taken in watering both sets of beds was 40 hours 27 minutes while the corresponding ridges occupied 51 hours 49 minutes. Assuming that the flow was constant, the saving of water in the bed system was 25 per cent.

A further advantage of the bed system is that lucerne can be made to behave as a perennial in Bihar, when the fodder obtained in the second and third years is much more luscious than that of the first season. To accomplish this, the old crop must be manured and well cultivated in October as soon as the rains are over. This is done by top dressing with Chinese compost, at the rate of 20 carts to the acre, and breaking up the soil thoroughly with *khurpa* hoes after which the beds and channels are re-made. A plot treated in this way is now in its third season and is still doing well. Another benefit obtained by renovating the old crop is that green fodder is available in November and December at a time when the supplies of this material are often short. Cultivation by itself is not sufficient to renovate old lucerne in Bihar. Organic matter is needed as well. A recent trial carried out at Pusa showed that the result of top dressing old lucerne with Chinese compost once after the rains was to increase the yield of the next twelve months by 70 per cent.

In previous publications, the advantages of a supply of good lucerne hay in India have been emphasized. This material, as is well known, is an excellent fodder for all kinds of live stock and when pressed into bales is very valuable both for military purposes and as a famine reserve. I should like to reply to two criticisms which have been made to this suggestion. The first is that lucerne will not keep during the rains in India. Lucerne bales, compressed to the Army standard of 90 cubic feet to the ton, have been stored for six years on an open verandah at Pusa and the fodder is still palatable. Loose hay suffers no damage during the rains when stored in an ordinary *bhusa* shed. The second criticism is that lucerne hay cannot be made in India without loss of leaf, the most valuable portion of the fodder. Excellent hay is made in the ordinary routine at Pusa at all times of the year except during the monsoon and no loss of leaf takes place even in the driest

weather. Such damage is easily avoided if the fodder is always handled when it is slightly damp with the morning dew. It is possible that the difficulties encountered in making lucerne hay may be due to want of skill on the part of the labour employed. If so, this can easily be remedied by importing, for training purposes, a few intelligent cultivators from the tobacco tracts of North Bihar. Here the people are accustomed in tobacco curing to handle, without breakage, a very brittle product. It is much easier to make good lucerne hay than it is to cure tobacco.

Two things are necessary before lucerne can be introduced into the rural economy of the country good demonstration work and a reliable supply of seed of a suitable variety. To initiate the demonstration work, it is suggested that every Government farm should maintain a well-managed plot of lucerne for the use of its work cattle. The seed supply is a more difficult matter as in many places lucerne does not seed well. Preliminary experiments, carried out by Mr. Habonto Banerji, M.Sc., a Research Student in the Botanical Section of the Pusa Institute, indicate that the fertilization of the lucerne flower is limited by temperature. Well-developed pollen grains are formed even in the hottest weather but they do not germinate unless they are artificially cooled. Seed growing is therefore likely to be most successful in the colder parts of North West India and on the more elevated regions of the Peninsula. Some of the hill tracts, including the Kashmir valley, may also contribute to the seed supply.

THE SUN-DRIED POONA FIG.

BY

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AND

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THE growing of figs in Western India is almost a speciality of the Poona District. But, in as much as they will not carry far in good condition, the cultivation, for which the tract is very suitable, cannot expand beyond a very small area. At the same time, the Bombay Presidency alone imports nearly five lakhs of pounds of dried figs from abroad each year, chiefly from the Persian Gulf, Afghanistan and Greece. The best among these figs are sold at R. 1-8 per pound in the months of August and September in the Bombay market, but if the Poona figs can be dried satisfactorily and put on the market, they can be sold at ten annas a pound and still yield a handsome profit, and will be in great demand, especially from June to September, when there is a scarcity of foreign figs.

In any case dried figs have a world market. The principal exporting centres before the war were Turkey (by far the largest), Italy, Greece and Algeria, while the large consuming countries were the United Kingdom, the United States of America, Austria-Hungary, France and Russia. To capture the foreign market is perhaps a far distant goal, but it is certainly well worth while to see whether good dried figs can be economically produced suitable for the Indian market. If this were found possible, the present area of figs in the Poona District (1,064 acres) would soon rapidly increase

The Poona fig is a medium-sized, bell-shaped, light purple-coloured fig and is, in good samples, nearly six inches in circumference at the broadest end. The stalk is long and the apex flat. The skin is thin, ridged, slightly downy, and is easily removable. The pulp is rosy red. The seeds are soft and without a kernel. The average weight of the fresh fruit is one and a half ounces. On analysis, in the chemical laboratories of the Bombay Agricultural Department, the fresh fruit gave the following figures:—

	Per cent.
Moisture	75·0
Reducing sugars	15·2
Non-reducing sugars	2·1
TOTAL SUGAR	17·3

The completely dried fig gave the following additional data on analysis:—

	Per cent.
Ash	3·2
Ether extract	0·7
Proteids	4·7
Digestible carbohydrates	89·3
Woody fibre	2·1

The dried figs which we have been able to prepare from these fruits are not so sweet and aromatic as the first grade Smyrna fig, but their size, colour and the softness of the meat are very attractive. Their market quality is at least as good as that of any dried figs available in the local market, and is probably superior to all. On analysis they gave the following figures, compared with those of foreign figs available:

	Moisture	Reducing sugars
	Per cent.	Per cent.
Sun-dried Poona fig ..	19·25	45·95
Persian fig, Sample I ..	19·45	46·30
Persian fig, Sample II ..	19·90	45·70
Afghanistan fig	19·04	46·64
Grecian fig	19·14	46·50

The process of drying and curing figs differs somewhat in different countries, largely on account of the differences in the cultivated figs themselves. They are extensively dried in Turkey in Asia, Greece, Italy, France, Spain, Portugal and Egypt and more recently in California. In Asia Minor and Greece, figs are only sun-dried on drying floors. In Italy, figs are split lengthwise, dried in the sun, dipped for a moment in boiling water, which is then drained off. In France they are exposed to the sun as in Turkey, and then after two or three days' exposure, they are sweated for forty-eight hours in boxes and again finally dried in the sun. In California fresh figs are treated with burning sulphur fumes. Salting of fresh or half dried figs is also regarded as an important operation in many centres, but its use with the Poona figs has not, in our experience, increased the market value.

A series of experiments with the drying of the Poona fig has led to the following process as suitable to them.

Well ripened figs are carefully picked. Careful picking is essential. The contents of figs subject to careless picking always ooze out while drying, and attract ants and flies during the drying process. Fresh fruits are then spread in single layers and exposed to moist sulphur fumes in a closed wooden box. The exposure to moist sulphur fumes bleaches the fruits and makes them semi-transparent. The fumigation, too, checks the growth of micro-organisms, which would otherwise spoil the fruits during the curing period. The simplest method of fumigating with sulphur fumes is to ignite flowers of sulphur below perforated trays, which are made to slide one above the other on cleats nailed to the sides of an ordinary closed wooden box. The lowest tray, which is at least eighteen inches above the bottom of the box, is moistened with water and does not contain any figs.

Numerous experiments with various modifications of the treatment lead to the conclusion that twenty to thirty minutes' exposure to sulphur fumes is essential to get tasteful produce. Longer exposure, however, encourages acidity which is undesirable. If the figs are not sulphured, the final colour is dark and unattractive, and a preliminary dipping in boiling water containing salt gave no

advantage, for though the taste was good, yet the final colour was not very attractive and the figs took a little longer to dry.

Immediately after sulphuring in the manner described, the figs are exposed to the sun in open trays and turned over daily in order to get the fruit evenly dried and semi-transparent in appearance. If this operation is neglected, the bright appearance of the dried fruit is lost.

The months of April and May seem to be the best for drying figs in the sun, as there is then no fear of rain. Five days are needed for completing the drying properly, and the figs, if well dried, are pliable and semi-transparent, and are reduced to a little less than one-third the original weight. The moisture contents of the dried figs range between 17 and $22\frac{1}{2}$ per cent.

Before drying is completed, figs are pulled flat as evenly and neatly as possible to economize packing space and to improve the market appearance. Neatly pulled figs take a circular shape with their eyes in the centre on one side and the stalk on the other. If these instructions are carefully observed, a product much superior to the commonly obtainable foreign figs can be put in the market. There is, in fact, great scope for developing a fig drying industry in the Bombay Presidency.

As this industry does not require any capital outlay, at any rate when conducted by the small cultivators who now grow figs, it can be easily taken up by the villagers as a cottage industry, particularly when the price of fresh figs is very low, as is usually the case in the month of May and the first half of June each year.

Selected Articles

A LAND MORTGAGE BANK.*

BY

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Board of Revenue, United Provinces.

In 1913 a financial crisis in Northern India led to the closing of several ordinary joint-stock banks. The liquidation proceedings showed that the conduct of their business had differed from that of an English or Scottish bank, in that a considerable proportion of the funds available from deposits at call or for a short fixed term had been lent on the security of land or buildings. As a result of the shock those banks which survived became more chary of placing money on mortgage, and when the Great War began in 1914 credit was still further curtailed. Persons in Northern India who wish to borrow money on the security of land experience far more difficulty in obtaining loans than they did ten years ago. There is a clear opening for a bank which would provide specially for this class of business while safe-guarding itself against the factors which make it dangerous for an ordinary bank to lock up money in mortgages.

Simply stated, the problem is to attract money on long term deposit, to arrange for accurate and inexpensive verification of title and security, and to ensure that money raised is completely and continuously invested, so as to bring in a return. These requirements had been satisfactorily met many years before the war

* Reprinted from *Ind. Jour. Eco.*, IV. 2.

by the Nobles' Government Land Bank in Russia.[1] A more recent experiment is the system begun in the United States of America under the authority of the Federal Farm Loan Act passed on 17th July, 1916.[2] The essential feature of both institutions is that money is borrowed on long term bonds and lent on mortgage at a higher rate of interest, the difference being usually one per cent. From the margin are met expenses of management. In Russia where the bank was a Government institution any further profits gained were applied to the reduction of debt. In the United States the banks must carry to reserve 25 per cent. of net earnings each half year until the reserve amounts to 20 per cent. of the outstanding capital. Subsequently only 5 per cent. need be so allotted, and the balance is available for distribution to shareholders.

As the American system was devised after careful study of the working of banks of this type in various European countries, a more detailed description is needed. The preamble of the Act includes among the objects of legislation the provision of capital for agricultural development, the creation of standard forms of investment based on farm mortgage, and the equalization of rates of interest based on farm loans. Two distinct classes of institutions have been formed: the Federal Land Banks which provide for the needs of the small landowner, and have some elements of co-operative principles, and the Joint-stock Land Banks which have larger transactions, and work more nearly on ordinary banking lines. Control over the administration of the Act is vested in a council of five, known as the Federal Farm Loan Board, which is attached to the Department of the Treasury at Washington, the Secretary to the Treasury being *ex-officio* Chairman of the Board. The remaining four members, who are whole-time salaried officials, are appointed by the President. In selecting them he is limited by the proviso that not more than two shall be chosen from one political party.

[1] A full account of this is given at page 77 of the *Monthly Bulletin of Economic and Social Intelligence* for September 1914.

[2] Described at page 689, *The Economist*, 21st April, 1917. An account of the working during the first two or three years was reprinted from *The Economist* at page 100 of the *Agri. Jour. India*, XV, 1.

For the purposes of the Act the whole area of the United States was divided into twelve districts. A Federal Land Bank was constituted for each district, and, if necessary, branch banks will be formed within the same area. Joint-stock Land Banks, however, are incorporated in a State, and their operations are limited to that State and one adjacent State. The working of the Federal Land Banks depends on the formation of National Farm Loan Associations. An association may be formed of ten or more persons. Each member must be possessed, or about to become the owner, of land suitable as security for an advance. Loans by a Federal Land Bank are made only to members of an association and on the recommendation of the association. They must be used only for specific purposes such as purchase of new land, of stock, or of fertilizers. A borrower must hold stock in the local association equal to 5 per cent. of the loan applied for, but provision is made to enable the member to obtain from the Federal Land Bank the necessary cash to purchase this stock. A loan must not be for less than $100 or for more than $10,000. Its term must lie between 5 and 40 years, and its amount may not exceed 50 per cent. of the land mortgaged plus 20 per cent. of the value of permanent improvements. Loans made by a Joint-stock Land Bank are not limited in amount, but are subject to approval by the directors of the bank and by the Federal Farm Loan Board.

For each Federal Land Bank a capital of $750,000, in shares of $5 each, was fixed. For 30 days subscription lists were open to the public. Any capital not taken up privately was subscribed by Government. Shares owned by individuals or corporations rank for dividend, while those standing in the name of Government receive nothing. On the other hand, each share held by Government or by a Farm Loan Association carries a vote, and private shareholders have no voice in the administration. The Farm Loan Associations have gradually taken over the Government shares, as when a loan was made the association had to subscribe a sum equal to 5 per cent. of the loan to the stock of the bank. This gradual acquisition of capital carried with it an extension of popular control over the working of the bank. At the outset management

of a bank was entrusted to five directors selected by the Federal Farm Loan Board from residents in the district. When the stock owned by National Farm Loan Associations in a Federal Land Bank amounted to $100,000, the number of directors was increased to nine, six of these being chosen by directors of the associations and three continuing to be appointed by the Board. Each director must have been resident in his district for at least two years and, if the Federal Farm Loan Board approves, may be paid for his services.

Joint-stock Land Banks have a freer constitution. Shareholders have votes and the chief restriction is that business may not begin until a capital of $250,000 has been subscribed, of which at least half must be paid up. When that stage is reached a charter will be given by the Federal Farm Loan Board.

Further funds for providing loans are obtained by the issue of bonds for which the mortgages already taken form collateral security. These bonds are in denominations of $25, $50, $100, $500 and $1,000, in series of not less than $50,000. They are for specified minimum and maximum periods, subject to retirement at the option of the Bank. They can be issued only with the authority of the Federal Farm Loan Board, and the issue is regulated by a Farm Loan Registrar appointed in each district. A Joint-stock Bank cannot issue any bonds until its entire capital is paid up. The total issue of bonds by a bank at any time is limited to 20 times the capital in the case of Federal Land Banks and to 15 times in the case of Joint-stock Land Banks. There are simple provisions for increasing the original capital and thus providing for the issue of fresh bonds, when the original borrowing powers are exhausted. Both classes of banks may receive deposits of public money, subject to the approval of the Secretary of the Treasury. As Government funds may not be invested in farm loan bonds or farm mortgages, such deposits do not add to the resources of the bank. No other deposits of current funds payable on demand may be received except from a bank's own stock-holders.

Bonds were at first issued bearing interest at $4\frac{1}{2}$ per cent., but later it was found necessary to raise this to 5 per cent. On

loans the rate of interest must not exceed the rate fixed for the latest issue of bonds by more than one per cent. Bonds issued by any of the twelve Federal Banks are secured by the joint liability of all twelve. A Joint-stock Land Bank is liable only for its own bonds. Although the State is intimately concerned with control and supervision, it undertakes no liability. It has been held by the Supreme Court, however, that the bonds are 'instrumentalities' of the Government. It is not clear what general effect this ruling has, except that it declares the bonds free of all taxation except inheritance taxes. While the constitution of National Farm Associations and their relations to the Federal Land Banks have some affinity to the case of primary credit societies and district banks in the Indian co-operative system, an important difference must be noted. It is expressly provided by the Act that the liability of a shareholder in an association for contracts, debts and engagements of that association is limited to the extent of stock held by him at par value in addition to the amount paid in and represented by his share.

The new system has been immensely popular. Within two or three years from the commencement of the Act the Federal Land Banks had lent more than $160,000,000 while the Joint-stock Land Banks had issued about $50,000,000. Public issues, which were arranged through ordinary financial houses, were taken up almost immediately. In Russia it was the practice to make over the bonds to the borrower who disposed of them as he pleased.

In suggesting the organization of Land Banks in India regard must be had to a number of factors, which differ from those affecting the problem in other countries. First among these is the question of the title of the landowner. The needs of the cultivator in zemindari provinces or in the ryotwari provinces of western and southern India may be excluded. These can best be supplied in present circumstance by co-operative credit societies, or by the Government system of taqavi. In several provinces moreover the cultivator has no saleable interest, and cannot legally encumber his holding. Laws of inheritance, the absence of a compulsory system of registration of marriages, births, adoptions (except the

talukdars of Oudh) and deaths combine to throw frequent doubts on the security of title, while the lack of restraint on champertous suits gives opportunities which wealthy blackmailers have readily taken. In the United Provinces there are few large estates the title to which has not been challenged once at least since the establishment of British rule. Such difficulties of verification do not exist in America. In Russia branches of the Nobles' Bank were frequently under the same management as the corresponding branches of the Peasants' Bank, the work being done chiefly by functionaries of the latter. It is significant that in England solicitors who are in touch with local conditions are the chief agents in collecting and placing money invested in mortgages.

Another salient feature of the position in India is that the demand for money secured on land is not chiefly dictated by useful aims such as those for which loans are limited under the American Act. It is true that money is often borrowed for the purchase of fresh land, but far greater debts have accumulated through litigation, mismanagement, general extravagance, and misfortunes due to bad seasons which had not been provided against or promptly repaired. Borrowing for remunerative improvements or for increasing stock is still inconsiderable, though Government is already willing to lend money for such purposes at rates which are probably as low as a Land Bank could offer. These considerations are so real that when a scheme for a Land Mortgage Bank was discussed by some astute landowners a few years ago, they contemplated asking that the owners of heavily indebted estates should entrust the management to their association during the subsistence of a mortgage. Such an arrangement would not suit a solvent landowner who wished to borrow for purchase of new land.

It is obvious that neither type of the American Banks is directly suited to Indian conditions.* A bank on the lines of a Federal Land Bank could not deal cheaply and efficiently with applications for small loans for improvement or purchase of stock, such as could be obtained from Government under the Land Improvement Act.

* I refer more particularly in the following remarks to the United Provinces, with which I am most familiar.

An official executive staff is already available to make preliminary enquiries into title and encumbrances, to inspect the progress of the work for which an advance is required, so that instalments of the loan are not diverted to other objects, and finally to ensure punctual repayment. There would be considerable objections to allowing a bank to make use of the services of the district executive staff, owing to the danger of friction, delay and lack of responsibility as Government could not give any guarantees to the bank. Unless the banks can provide money more cheaply than the money-lender and promptly they cannot be a financial success, and until business is developed by the existing Government system the banks would not have enough to do. Loans for purchase of new land are not immediately likely to supply the deficit. The science of agronomics is still too little known to have stimulated men of the land-owning class. Purchases are generally made from hoarded capital, or by the money-lending classes. At the present stage of co-operative development little help is likely to be obtained from co-operative credit societies. To be of assistance they would need knowledge and authority, but both these would be lacking. If loans were strictly limited to useful purposes, such as the purchase of land and improvements, more assistance could, however, be obtained from the landowners' associations which are establishing a certain position, though their activities have not yet proceeded in this direction. The operations of the Agricultural Department, and the diffusion of education have had an effect on the land-owning classes, and the provision of cheap capital would undoubtedly tend to facilitate the transfer of land to more capable hands than those from which it is slipping. Recent settlement reports in the United Provinces indicate that in spite of many transfers the land-owning castes are maintaining their aggregate holdings. Special enquiries undertaken by Government a few years ago showed that mismanagement and indebtedness were less serious than had been popularly believed.

While the establishment of Joint-stock Land Banks, though desirable, would be a doubtful experiment at present, there is an opening for such a bank with a specially limited scope, which would test the market for investment and help to familiarize the idea.

Its charter should be framed so as to enable it to extend its operation when its success has justified this. The bank proposed would, in the first instance, be limited to lending money to the Court of Wards in a single province. A bank constituted for a group of provinces would have a wider field for the collection of capital, but difficulties would arise when operations are extended and loans begin to be made to landowners whose estates are not under the management of the Court of Wards.

The powers and functions of the Court of Wards are regulated by Acts of the Provincial Legislature and vary from province to province. In the United Provinces the administration is vested in the Court of Wards (which at present is the Board of Revenue) subject to the general control of Government. If an estate falls into the hands of certain classes of proprietors, management may be assumed, if there is good reason to believe that management by the proprietor would not be successful. Estates in this category are chiefly those belonging to females or minors. A major owner who declares himself incompetent to manage his own affairs may apply to the Court of Wards to administer his estate. Lastly, it is open to Government to direct a formal enquiry into the indebtedness of an estate, and if it is found that the interest on the debt exceeds a certain proportion of the net income of the estate, to authorize management by the Court of Wards whether the owner desires it or not. In deciding whether an estate should be taken under management various factors are considered. While the disintegration of a large estate invariably causes distress to the tenants it is not advisable to interfere in every case. It is clearly right to preserve an ancient name when there is a young heir who may be trained to bear it more wisely than his predecessor. On the other hand, it may be found, when application is made, or when enquiries are directed, that debts cannot be paid in full except by tedious liquidation and the sale of almost the whole of a property. The Court of Wards is naturally reluctant to assume the function of a liquidator in bankruptcy proceedings. The fact remains that a considerable number of the estates managed by the Court of Wards in the United Provinces are burdened with debt. During

the last 15 years the aggregate debt owed by such estates has never been less than $1\frac{1}{2}$ crores and it has approached $2\frac{1}{2}$ crores. Only a comparatively small portion has been incurred for productive purposes and the balance has been a dead weight to be slowly reduced by careful management. When an estate is taken over it is usually found that the rate of interest payable on its debts is higher than the rate at which the Court of Wards can borrow on behalf of estates under its management. Old debts at high interest are therefore paid off by new loans. Before 1913 ordinary joint-stock banks were glad to invest some of their resources in this way. In one particular year when the total debt approached two crores the percentage held by different classes of creditors was as follows:—

(1) Joint-stock banks	30
(2) Government	23
(3) Solvent estates under management ..	13
(4) Educational and similar endowments ..	12
(5) Miscellaneous	22

Both figures for Government and miscellaneous creditors were unusually large. As a rule Government does not lend money to clear estates from debt. Several very exceptional loans had been made immediately before the year taken as an example. Since 1913 the proportion lent by joint-stock banks has been considerably reduced, and at times the Court of Wards has had difficulty in obtaining single large sums.

It has been suggested above that the business of lending money to estates under Court of Wards management is safer than lending on mortgage to an ordinary landowner. Joint-stock banks used to give to the Court of Wards better terms than they offered to the public. It is well known that although the Court of Wards gave no guarantee, no losses were incurred. For the improvement of the security there are in fact special reasons. Chapter IV of the U. P. Court of Wards Act (IV of 1912) lays down a definite procedure for ascertaining the indebtedness of an estate. The date of assumption of charge is notified publicly. Claims against the estate which are not preferred within six months of that date are extinguished. The

claims are enquired into by the district officer before admission by the Court of Wards. Thus a bank is saved tedious and expensive enquiries into title and encumbrances. After admission of a debt the district officer may reduce the amount of interest payable on it for a period not exceeding two years, during which the Court of Wards has time to raise a fresh loan at leisure. When the preliminary enquiries show that an estate is involved to such an extent that little or nothing can be saved, a fresh debt is not incurred and the estate is released, so that there is practically no danger of a bad debt. There are also certain restrictions on the discretion of the Court of Wards which increase the security of the creditor. Priority is ensured for the liquidation of debts on the estates over all other classes of expenditure except charges necessary for maintenance and education, for management and supervision and for public demands or sums payable to a superior proprietor. When steps have once been taken for the liquidation of debts and liabilities, and liquidation is not yet complete, the Court of Wards may not relinquish charge without previously obtaining the sanction of Government. If a dispute arises about succession, the Court of Wards can institute an interpleader suit or arrange for arbitration. All these provisions unite to make the safety of a loan secured by mortgage on an estate under Court of Wards management as strong as is conceivable without a Government guarantee. Difficulties which have arisen in the last 8 or 9 years are due, not to any deterioration in the security, but to the realization in India of the principle always followed in England and Scotland, that banks accepting deposits at call must be chary of locking up money in mortgages.

There is every reason to believe that the bonds would have a ready market. Indian war loans have proved attractive to a degree which had never been anticipated. Provincial loans in Bombay and the United Provinces have also attracted investors. Shares and bonds in the proposed bank would have the tangible security of mortgages. A joint-stock bank could take up such bonds without embarrassment, as they would be readily saleable and divisible. They would be considered attractive by insurance companies,

Co-operative credit societies at present place idle money in fixed deposits in joint-stock banks. If a sudden emergency forces them to withdraw this money before due time they lose any interest which has accrued. Solvent estates under the management of the Court of Wards are hampered by the rigid, but necessary, restrictions on the manner in which their surplus funds may be invested. They cannot deposit money in ordinary banks, and many have balances which lie idle until a suitable mortgage can be arranged or a village comes into the market.

It is therefore suggested that legislation should be undertaken to enable banks on a provincial basis to be chartered for financing estates under Court of Wards management. It would be obligatory on the Court of Wards, in a province for which such a bank was constituted, to apply to the bank in the first instance. The grant of a loan would of course be at the discretion of the bank. No restriction would be made as to the purpose of the loan, for it has already been shown that the bulk of the money would be needed for repayment of debt already incurred. A capital of five lakhs would suffice at first, with provision for issue of bonds, when that was all used, up to a maximum of one crore. It should be possible to increase the capital when that became necessary. The American provision regarding formation of a reserve in the case of Federal Land Banks should be followed. Bonds should be issued through the Imperial Bank of India and should bear interest at a rate one per cent. lower than the rate at which loans are made. It would be unnecessary for the bank to handle any cash except for salaries and expenses of the head office if Government would make two concessions. Estates under Court of Wards management at present bank with Government treasuries. It is a simple extension to allow treasuries to receive subscriptions for capital or bonds and instalments of principal repaid, and to make interest on shares and bonds payable at treasuries. The directorate should include one Government representative, but otherwise should be elected by the shareholders.

While it is suggested that the bank should at first lend only to Court of Wards estates, it is desirable to take power to extend

its operations, when a suitable reserve has been accumulated, to landowners who desire to purchase fresh land or make improvements. It would no doubt be preferable to constitute a separate bank for this purpose. But, while a small genuine demand has already arisen, it is not sufficiently large to justify the formation of a separate institution. On the other hand, if the possibility of an extension to include this class of business is contemplated, it should be clearly before subscribers to the Court of Wards Bank from the outset. It has been explained above that the smaller needs of landowners are already provided more cheaply by the Government agency for grant of loans than could be done by a private bank, but it is permissible to look forward to a time when land banks working perhaps with co-operative district banks will relieve Government officials of this business also. I expressly refrain from discussion here of a bank with power to lend money to indebted proprietors whose estates are not under management to enable them to get free from debt. Such a scheme would probably include the grant of powers to the bank to acquire a usufructuary mortgage of the estate and to arrange for its management.

THE INHERITANCE OF THE NUMBER OF BOLL LOCULI IN COTTON.*

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Introduction.

The inheritance of characters of division, or meristic characters, such as the number of loculi into which a capsule is divided, has so far received little attention from genetic workers, though Bateson[1] has called attention to their interest. Such scanty results as have been obtained may be briefly alluded to. Hildebrand,[2] working with 3-fold and 4-fold leaflets of *Oxalis latifolia*, found the 3-fold character imperfectly dominant, the leaves being 3-fold with the exception of an occasional 4-fold leaf which appeared at the flowering period. In the tomato, Price and Drinkard[3] found that the bilocular condition of the fruit was dominant to the plurilocular, though no observations on subsequent generations seem to have been published. A few data on the inheritance of the number of carpels in flowers of *Bryonia dioica* were obtained by Jones and Rayner,[4] who concluded that the proportion of two-carpellary to three-carpellary flowers, as evidenced by the number of stigma lobes, and of placentæ in the ovary of the flower, could be interpreted by assuming the co-operation of two factors.

The only case where the inheritance of a meristic character seemed to have been clearly demonstrated—reduction of the number

* Reprinted from *Jour. Text. Inst.*, XIV, 12.

[1] Bateson. *Mendel's Principles of Heredity*, Cambridge, 1913.

[2] Hildebrand, Jena. *Zeitsch. Naturwiss.*, 1889, **23**, Neue Folge 16, p. 56.

[3] Price and Drinkard. *Virginia Agric. Exp. Sta. Bull.* 117, 1908.

[4] Jones and Rayner, J. *Genetics*, 1916, **5**, 203-224.

of phalanges in the hands of human beings—has been shown not to be a true meristic character.

In *Gossypium*, the boll is divided into 2-6 loculi. On a single plant there may be a mixture of bolls with different loculi number, or all the bolls may be of one number. The following combinations have been seen: (*a*) 2 and 3; (*b*) 3 and 4; (*c*) 3, 4 and 5, and doubtless other combinations are possible.

In a pure line, the proportion of bolls of different numbers is constant from year to year. Poor environmental conditions tend to depress the mean loculus number; thus a strain which produces normally 60 per cent. of 4-locked bolls and 40 per cent. of 3-locked bolls will have the percentage of 4's reduced very considerably under any conditions which tend to dwarf the plant, such as poor soil or lack of water. The large number of different types of distribution of loculus number in cotton make this plant a very suitable subject for experiment.

Previous work on the inheritance of loculus number in cotton.

The only accurate observations on this subject are those of Balls,[1] who studied the mode of inheritance of this character in hybrids between Egyptian and American cottons, and also in crosses between different strains of Egyptian. He states: –

"A cross between an Upland with its mean at 4·3 and an Egyptian with a mean at 3·0 produced an intermediate F_1 with the formula 4·1. In F_2 this family gave a range of 3·0 to 4·7 with modes at 3·2, 3·6, 4·1, 4·4, and possibly elsewhere. In F_3 a 4·8 bred true to 4·8 and a 3·1 bred true to 3·2..... On the other hand, 3·3 broke up into a scatter from 3·1 to 3·7 as did also a 3·6. A 3·9 plant appeared to breed true round a mean of 4·1, while a 3·8 scattered from 3·9 to 3·3. Similarly a 4·0 scattered from 3·9 to 3·2 and so on. On the data available, it seemed clear that parental forms could be extracted and bred true, while the

[1] Balls, *Cotton Plant in Egypt*, London, 1919.

intermediate forms represented new gametic combinations which broke up in new ways giving new forms."

The inter-Egyptian crosses, made by Balls, which were expected to give simpler results, proved to be equally difficult to analyse. Sultani (3·2) crossed with Afifi (2·8) gave an F_1 at 3·0. The F_2 broke up with great symmetry over the parental extremes, with a single mode at the F_1 value. The spread of this curve was too narrow to be considered as the expression of a 1 : 2 : 1 ratio.

The experimental results.

The cottons used in the present experiments comprised three types of Sea Island, which were considered to be homozygous for all visible characters, having been self-fertilized for five generations, and three types of West Indian perennial, native to St. Croix and St. Vincent and Jamaica, respectively. These had been observed to breed true from the time of their introduction into pedigree culture. A pure type of Upland was also used. Data showing the number of 3, 4 and 5 locked bolls in each of the cottons will be found below :—

Cotton	3-locked	4-locked	5-locked	Mean
	Per cent.	Per cent.	Per cent.	Per cent.
AR (Sea Island) ..	97	3	..	3·0 Loculi
BD („ „) ..	39	59	2	3·6
BF („ „) ..	47	52	1	3·5
St. Vincent Native ..	40	60	..	3·6
St. Croix Native ..	23	77	..	3·8
Canto (Jamaica) ..	99	1	..	3·0
Upland	16	74	10	3·9 (single plant)

1. *The Inter-Sea Island Cross, AR* (3·0) *by BD* (3·6) *and BF* (3·5).

This cross was made reciprocally, and the frequency distributions of mean boll loculi for the parents, F_1, F_2, and F_3 families

are shown in Table I, together with the usual biometric data. The conclusions to be drawn from this table may be set out as follows:—

(*i*) The means of the F_1 families are practically the same (3·2) and, although intermediate, lie closer to the mean of the lower parent.

(*ii*) The variability of the F_1 families, as shown by the values for standard deviation and coefficient of variability, is less than that of the more variable parent.

(*iii*) The means of the F_2 families are close to those of F_1, while the standard deviations show that the F_2 varies considerably more than either of the two parents or the F_1. The range of F_2 is from 3·0 to 3·8, thus embracing the complete range of both parents.

(*iv*) Only 13 F_3 families were grown, but the results of these throw some light on the mode of inheritance of loculus number.

The behaviour of the F_2 families may be summarized thus:—

F_2 parent.	Behaviour of F_3 family.
3·0	Three families bred true.
3·1	Two families bred true.
3·2	Probably heterozygous (two families), and segregating into medium and low. Evidence exists of a homozygous form at 3·3.
3·3	Of two families, one is apparently heterozygous with range 3·1 to 3·6 and the other is true to 3·1.
3·4	One family, spread from 3·1 to 3·5 with a mode at 3·3.
3·6	One family, spread from 3·2 to 3·5 with a mode at 3·3.
3·7	One family behaved like the F_2 and spread from 3·0 to 3·8 with a mode at 3·2.

The small number of F_3 families does not enable any hypothesis to be put forward as to the inheritance of boll loculi in the Inter-Sea Island crosses just described, though it is clear that there would be no insuperable difficulties in the way of a factorial interpretation of the results, provided that the crosses were analysed for a sufficient number of generations.

TABLE 1.

The Inter-Sea Island Crosses AR (3·0) × BD (3·6) and Reciprocal; AR (3·0) × BF (3·5) and Reciprocal.

Family	Generation	3·0	3·1	3·2	3·3	3·4	3·5	3·6	3·7	3·8	Mean	Probable error, P. E.	Standard deviation σ	Coefficient of variability, C. V.
AR	P_1	40	8	..	..	..	..	..	..	..	3·02	0·004	0·04	1·24
BD	P_1	..	..	..	..	3	10	11	14	1	3·60	0·001	0·10	2·81
AR × BD ..	F_1	..	14	12	11	4	..	..	..	..	3·21	0·001	0·10	2·78
BD × AR ..	F_1	..	27	20	20	4	1	..	..	..	3·25	0·007	0·09	2·77
10-3	F_2	2	2	3	4	2	..	1	..	..	3·24	0·029	0·16	4·94
10-4	F_2	1	7	1	1	1	..	1	..	..	3·18	0·031	0·16	5·03
10-3-6	F_3	15	16	..	..	..	..	..	..	..	3·05	0·006	0·05	1·64
10-3-7	F_3	12	14	..	..	..	..	..	..	..	3·05	0·007	0·05	1·64
10-3-11	F_3	..	4	5	9	9	1	2	..	..	3·31	0·016	0·13	3·93
10-3-14	F_3	23	4	..	..	..	..	..	..	..	3·01	0·001	0·01	0·33
AR	P_1	30	8	..	..	..	..	..	..	..	3·02	0·004	0·04	1·24
BF	P_1	..	..	1	..	..	4	8	2	2	3·53	0·019	0·14	3·98
AR × BF ..	F_1	..	34	40	22	5	2	..	..	..	3·20	0·002	0·03	2·98
BF × AR ..	F_1	1	28	24	10	3	..	..	..	..	3·18	0·002	0·03	2·73
12-1	F_2	1	8	10	4	4	2	1	..	..	3·24	0·017	0·14	4·41
12-2	F_2	1	4	2	3	4	2	..	..	..	3·27	0·025	0·15	4·72
12-3	F_2	..	3	11	2	4	2	1	..	..	3·27	0·018	0·13	4·17
12-4	F_2	1	14	16	15	8	10	4	..	2	3·30	0·015	0·18	5·32
12-6	F_2	..	16	17	8	3	5	5	1	1	3·28	0·016	0·18	5·50
12-7	F_2	..	..	2	6	1	..	..	..	..	3·28	0·013	0·06	1·75
TOTAL ..	F_2	3	45	58	38	24	21	11	1	3	3·28	0·008	0·17	5·05
12-2-9	F	10	17	2	..	..	..	..	..	..	3·07	0·008	0·06	1·54
12-1-11	F	10	15	3	..	..	..	..	..	..	3·07	0·008	0·06	1·94
12-1-19	F	1	16	3	3	..	..	..	..	..	3·14	0·009	0·07	2·38
12-4-13	F	3	9	4	1	..	..	..	..	..	3·15	0·014	0·10	3·06
12-7-1	F	16	3	1	7	..	..	..	..	..	3·03	0·009	0·07	2·42
12-1-15	F	..	7	2	10	4	1	..	..	..	3·26	0·014	0·11	3·26
12-1-3	F	1	4	2	5	13	3	1	1	..	3·38	0·016	0·13	3·87
12-1-20	F	..	..	..	2	3	..	..	..	..	3·30	0·010	0·08	2·50

... St. Vincent Native × Upland (S. V. N.) and St. Croix Native × Upland (S. C. N.).

Family	Generation	3·2	3·3	3·4	3·5	3·6	3·7	3·8	3·9	4·0	4·1	4·2	4·3	4·4	4·5	4·6	4·7	4·8	4·9	5·0	Mean	P.E.	σ	C.V.
S. V. N. ..	P_1	..	2	3	9	14	8	5	2	..	..	..	..	..	..	..	..	..	..	..	3·6	0·014	0·14	3·89
Upland ..	P_1	..	..	..	..	..	..	..	..	..	2	14	10	..	..	..	..	..	..	..	4·2	0·007	0·06	1·43
S. V. N. × Upland	F_1	..	..	..	..	..	..	..	9	5	..	..	..	..	..	..	..	..	..	..	3·9	0·009	0·05	1·28
1–1 ..	F_2	..	..	..	..	1	1	2	5	10	7	3	2	2	2	..	..	..	..	..	4·06	0·023	0·20	5·00
1–1a ..	F_2	..	..	..	1	1	2	5	11	11	2	6	5	2	..	..	..	..	..	..	4·0	0·021	0·21	5·25
1·2 ..	F_2	..	..	..	..	3	—	2	6	8	5	1	1	—	—	—	1	..	..	..	4·0	0·031	0·24	6·00
1·3 ..	F_2	..	..	..	..	2	3	2	12	14	19	11	—	2	..	..	..	..	..	..	4·0	0·013	0·16	4·00
1–5 ..	F_2	1	—	—	—	1	2	3	8	14	4	1	4	5	1	..	..	..	..	..	4·0	0·025	0·25	6·25
1–5a ..	F_2	..	..	..	2	3	3	9	16	40	15	9	3	2	5	—	1	1	—	1	4·0	0·015	0·24	6·00
1–9 ..	F_2	..	..	..	1	2	—	5	10	5	6	1	3	1	..	..	..	..	..	..	4·0	0·035	0·30	7·50
TOTAL ..	F_2	1	..	..	4	13	11	28	68	102	58	32	18	14	8	—	2	1	—	1	4·0	0·008	0·22	5·50
1–2–6 ..	F_3*	..	..	..	..	..	..	2	2	4	7	3	1	2	1	..	..	..	..	..	4·1	0·026	0·18	4·39
1–2–32 ..	F_3	..	..	..	..	..	..	..	1	..	1	2	3	1	..	..	..	..	..	..	4·2	0·036	0·15	3·57
1–2–57 ..	F_3	..	..	..	..	..	3	4	5	5	1	..	..	..	..	..	..	..	..	..	3·9	0·020	0·13	3·33
1–2–110 ..	F_3	..	..	..	..	..	..	..	..	..	3	..	1	..	..	..	..	..	..	..	4·2	0·027	0·08	2·14
S. C. N. ..	P_1	..	..	..	..	10	19	20	13	3	..	..	..	..	..	..	..	..	..	..	3·8	0·009	0·11	2·92
Upland ..	P_1	..	..	..	..	..	..	..	..	5	8	22	27	7	3	..	..	..	..	..	4·2	0·009	0·11	2·59
S. C. N. × Upland	F_1	..	..	..	..	..	..	..	5	14	4	..	..	..	..	..	..	..	..	..	4·0	0·007	0·06	1·50
2–1 ..	F_2	..	..	..	..	..	1	3	6	11	10	5	1	1	..	..	..	..	..	..	4·0	0·015	0·14	3·47
2–4 ..	F_2	..	..	..	..	2	3	8	7	7	3			2	1	..	..	..	..	..	3·9	0·024	0·21	5·38
2–5 ..	F_2	..	..	..	..	1	2	2	5	10	5	3	3	2	2	1	..	..	..	..	4·1	0·026	0·23	5·65
2–6 ..	F_2	..	..	..	..	1	1	2	2	7	8	3	2	2	—	1	1	..	..	..	4·1	0·028	0·23	5·62
2–7 ..	F_2	..	..	..	..	1	1	5	3	3	5	4	1	1	1	1	1	..	..	..	4·1	0·035	0·27	6·63
2–7b ..	F_2	..	..	..	1	3	2	4	5	4	3		1	2		2		..	..	..	3·9	0·037	0·29	7·27
2–11 ..	F_2	..	..	..	..	..	..	6	1	4	8	3	2	2	2	1	..	..	..	..	4·1	0·029	0·23	5·61
2–13 ..	F_2	..	..	..	..	1	2	3	3	7	4	4	5	3	..	1	3	..	..	..	4·1	0·031	0·28	6·78
2–14 ..	F_2	..	..	..	..	2	—	8	9	12	2	3	1	1	2	2	..	..	..	..	4·0	0·025	0·24	5·98
2–14a ..	F_2	..	..	..	..	1	2	—	4	9	8	1	5	2			1	..	..	..	4·1	0·023	0·21	5·15
TOTAL ..	F_2	..	..	..	1	12	16	42	48		56	29	21	18	8	9	6	..	..	.	4·1	0·009	0·24	5·85

* Values of F_2 parents not known.

TABLE III.

Results of the Cross, Cauto × Upland.

Family	Generation	3·0	3·1	3·2	3·3	3·4	3·5	3·6	3·7	3·8	3·9	4·0	4·1	4·2	4·3	4·4	4·5	4·6	4·7	Mean	P.E.	σ	C.V.
Cauto ..	P_1	12	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3·0	0·009	0·05	1·66
Upland ..	P_2	..	..	..	..	..	..	..	..	..	..	5	8	22	22	7	3	..	..	4·2	0·010	0·12	2·83
C×U ..	F_1	..	..	..	..	..	..	..	1	2	4	1	..	..	..	..	..	..	..	3·8	0·020	0·10	2·62
1–1 ..	F_2	..	1	..	—	4	5	5	17	11	4	5	7	2	4	1	1	5	1	3·9	0·032	0·38	9·79

2. *The Cross, St. Vincent Native* (3·6) *by Upland* (4·2).

The results of this cross (Table II) show similar features to those of the Sea-Island crosses just discussed. The F_1 is intermediate, and exactly at the arithmetic mean of the parents. The F_2 ranges from 3·2 to 5·0, thus showing the phenomenon of transgressive inheritance, with modes at 3·6 (lower parent), 4·0 (F_1) and 4·5. The mean of the F_2 is 4·0, near to F_1.

3. *The Cross, St. Croix Native* (3·8) *by Upland* (4·2).

The results are presented in Table III and are comparable with those of the St. Vincent Cross just discussed. The F_1 is again at the arithmetic mean of the parents, and the mean of the F_2 is near that of F_1. The phenomenon of transgressive inheritance is again shown though not so clearly as in the last cross.

4. *The Cross, Caoto* (3·0) *by Upland* (4·2).

The cross is interesting since it is between the two extreme limits of mean loculus number. The F_1 is intermediate, though this time the mean is nearer to that of the higher parent (Table III). The F_2 shows a wide scatter, and exceeds the upper limit of the Upland parent in six plants.

General conclusions.

From the standpoint of pure genetics the series of results presented in this paper are disappointing, though they are, perhaps, the most complete of any which deal with the inheritance of a meristic character. Exact knowledge of the mode of inheritance of boll loculi is carried scarcely any further than the point at which it was abandoned by Balls[1], but a survey of his results and those presented above will show clearly that: –

(*i*) Meristic characters are inherited, and there is strong evidence that the results are capable of being interpreted on a factorial basis.

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[1] Balls. *Cotton Plant in Egypt*. London, 1919.

(*ii*) New forms can be synthesised out (intermediate values), or analysed out (higher or lower values).

SUMMARY.

The results of crosses involving various types of loculus number in cotton are described, and it is concluded that meristic characters are inherited.

THE IRRIGATION OF SUGARCANE IN HAWAII.*

(CONCLUDED FROM VOL. XIX, PT. 2, P. 195.)

Conservation of water (prevention of losses from source to furrow) and soil moisture studies. It soon became obvious that to prevent serious loss in transport considerable attention would have to be paid to the water channels. Losses may occur in surface run-off, water and soil evaporation, leakage, seepage and deep percolation beyond the range of roots at different stages of growth. Such losses may occur in reservoirs or in transporting or delivering channels, and as far as these are permanent may be prevented or largely reduced. Owing to the large volumes of water dealt with and the great distances over which they have to travel, together with the porous nature of much of the Hawaiian soil, it became evident that some form of waterproofing of the channels was necessary † and that the channels should be kept in constant repair. A great deal of attention has been devoted in Hawaii to this vital matter in irrigation. The following appear to be the chief lining materials which have found favour from time to time, smoothness of lining surface being essential to pass the current quickly and thus to speed up the work and prevent undue evaporation. Flumes with wooden sides are specially liable to get out of order because of the material used, and a case is given where mere overhauling of the transporting flume resulted in increasing the water delivered by 18·55 per cent. The other lining materials mentioned by the author are cement or concrete reinforced by chicken wire (wire netting), concrete, precast concrete slabs, and rock or stone blocks. A number of details are given regarding the behaviour of all of these, and the matured opinions of a number of leading

* Reprinted from *The Int. Sugar Jour.*, XXV, p. 455.

† The writer of this review has met with a case where it was attempted to irrigate cane fields by an unlined channel some twelve miles long from a large reservoir. The loss of water by evaporation and seepage was found to be 95 per cent. before it reached the fields.

planters are freely quoted. The Pioneer Mill Company reports that its main transporting ditch, "which passes through the Honokahau tunnel seven miles long, was constructed in 1921 and has been in continual operation ever since. The walls are lined with plaster, reinforced with chicken wire, the whole being attached by heavy wire staples driven into the sides; the floors are cemented. The walls have proved very unsatisfactory. It is necessary to shut down the ditch for three days in each year and employ a large force of labour in plastering over hundreds of small holes and cracks. In some instances whole sections of the lining are torn off bodily. The seepage loss in dry weather flow amounts to 25 per cent." This is thoroughly typical of the general opinion regarding this material, which, however, can be used for short distances with advantage where the channel is only used intermittently (Fig. 4).

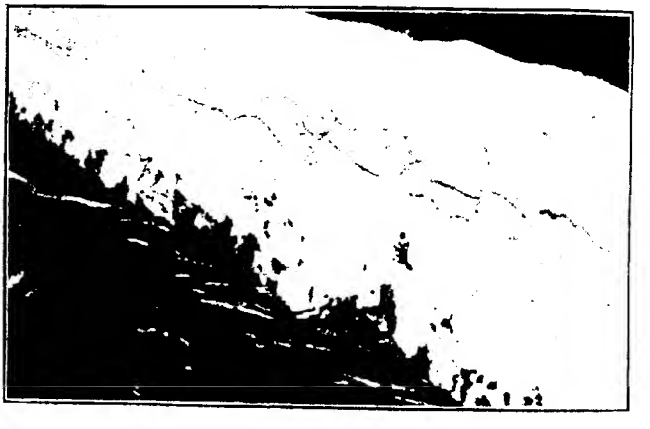


FIG. 4. Chicken wire and concrete plaster lining damaged by erosion and temperature cracks.

Concrete lining, on the other hand, is found to be very efficient but, to prevent cracking owing to changes in temperature, expansion joints have to be inserted at intervals. These were put in by one plantation at every 15 ft., while another has used 40 ft. but considers that shorter sections would be advisable. In gritty water the concrete lining has been found in time to be badly cut, and

expensive settling tanks have had to be inserted at intervals on one plantation. Pre-cast concrete slabs installed by Penhallow have met with approval on all hands (Figs. 5 and 6). These were described in our former article,[1] and although somewhat costly in the first instance are generally considered to have solved the problem of ditch lining. Cut stone or rock set in mortar is only used for excessively steep gradients, so as to withstand the great wear and tear. This material has proved satisfactory in such places, but it is found difficult to construct the channel so that the lining is perfectly impervious.

The level ditches cannot be lined, and the average loss by seepage has been estimated by Baldwin at the Maui Agricultural Company's Plantation at 22·6 per cent. The remedy suggested is to avoid all small irrigations, e.g., 1–2 men's irrigation on successive days should be replaced by 4–6 men's in one day only, thus lessening seepage and evaporation. A case is given when, because of water shortage, a large gang replaced 4–5 smaller ones for a time; the irrigation was completed in 22 instead of the usual 30 days, and at the end there was found to be 10 "men's water" left over. As to watercourses it is a moot point how much of the seepage water

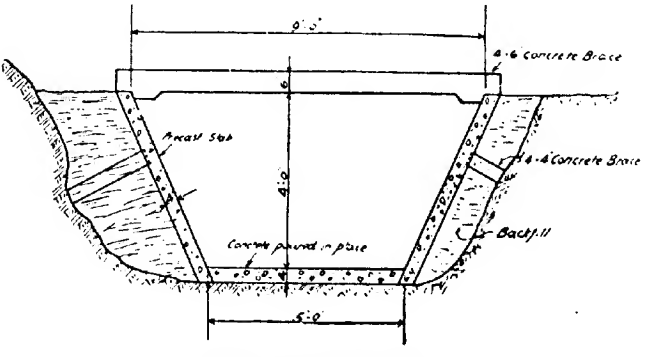
FIG. 5. Setting concrete slabs in place in flowing ditch.

[1] *Int. Sugar Jour.*, XXV, p. 181.

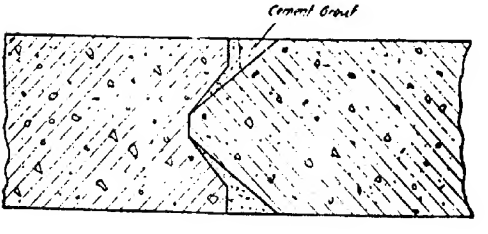
finds its way ultimately to cane roots. Baldwin attempted to settle this question by soil moisture tests. The water was run in for 1¼ hours, and two days later the increase in moisture 1 ft. off was found to be 3·85 per cent., at 2 ft. 3·12 per cent., and at 3 ft. 1·04. He therefore concluded that lateral percolation was slight. Allen holds that the loss from watercourses is not serious, and that the water finds its way somehow back to the cane roots.

The water in the furrow is disposed of, according to the author, in four ways: (1) surface run-off, due to leaking gates, carelessness and poor methods of irrigation; (2) soil evaporation, but this

WAILUKU SUGAR COMPANY



CROSS SECTION OF DITCH



DETAIL OF JOINT

FIG. 6.

becomes regulated as soon as the leaves close over the ground and through the natural mulch of self-stripping canes while the humidity of the Hawaiian climate acts as an additional check; (3) transpiration, but this serves a useful purpose, though weeds also transpire and clean weeding is therefore desirable (the author does not mention the quantity also taken up by the crop itself); (4) deep percolation, which is of most importance, that is the passage of the water below the root zone. He points out that the amount of water which the soil can hold varies with the texture, and gives the figures for the surface of the united particles of the three main types; the particle surface in an acre-foot of clay soil being 16,000 acres, in loam 10,500 and in sandy soil 3,250. Cane roots seldom reach below 4–5 ft., therefore all the water supplied should remain at that depth.

At Waipio sub-station (ordinary loam) the water movements were traced to 6 ft. from the surface, under 2 in., 6 in. and 9 in. irrigations. With the first it was found that 3 per cent. passed the 6 ft. line, with 6 in. the figure was 47 per cent., and with 9 in. 65 per cent. Under Waipio conditions it was determined that the upper 6 ft. of the soil could not retain more than $4\frac{1}{2}$ in., and it was therefore concluded that if more than this amount of water is applied the excess passes away and is lost. The soil moisture studies by the author agree with these figures. These studies were carried out between August 1921 and April 1922 on three areas on Ewa plantation differing in soil and slope of land; each soil moisture determination used was the result of three separate readings. The results are summarized on three charts with graphs representing the percentage of soil moisture each week at a series of different depths down to 5 or 6 ft. He found that the soils on the estate were saturated with a moisture content of 30 per cent., and any irrigation beyond this point was therefore wasted. Wilting (indicated by a slight curling of the leaf) occurred in warm weather when the soil moisture fell to 21 per cent. and slightly lower in the winter, and he therefore arbitrarily fixed on 25–28 per cent. as the point when irrigation is needed; soils with this amount of moisture still retain the "good feel" well known to experienced

irrigators. His data showed practically no upward capillary movement, drying out always proceeding downwards. During cold weather when growth and evaporation are at a minimum, sufficient soil moisture is retained for as long as three months at a time with comparatively slight rainfall, and irrigation is not needed, if indeed it is not harmful; but on the advent of warm weather the soil commences to dry very rapidly. Thus the soil moisture conditions vary with the season. Provided that drainage is adequate, it is probable that one year old cane can do with a far greater amount of water during the warm weather than is usually given. He concludes that it is not practicable to regulate irrigation practice by soil moisture measurements. For this to be effected on a large field, with its soil variations, composite samples are of little value, and the multiplicity of measurements which would be needed would be extremely cumbersome. Besides this there is another practical difficulty in a large field. Supposing that irrigation is commenced when the soil moisture is found to be 24 per cent., the irrigation work is too slow a process to prevent some parts of the field from suffering severely from lack of water. One cannot irrigate a 100-acre field in a day. The use then of soil moisture determinations is confined to check proper distribution and for purely research work. In actual practice, the accumulated experience of years of irrigating gives the overseer a kind of intuition as to when irrigation is needed; true, he probably errs on the side of over-irrigating, but he does not allow the leaves to show any signs of wilting and can afford a certain margin in keeping the plants fully employed in healthy growth, and he may be trusted not to waste any material amount of water.

In the remaining sections the author is much more concise, and it is chiefly in these that a more generous treatment would have been welcomed by outside readers, inasmuch as they are perhaps of more general interest to sugar planters. Considerations of the length of the thesis have doubtless had their influence in this curtailment.

Naturally, the time element in irrigation is of great importance where the labour shortage is so severely felt as it is in Hawaii.

The points considered in this section are whether irrigation of the furrows should commence at the upper or lower end of the watercourse, the volume of water used per man, the effect of stripping and of weeding and the age of the cane, and, lastly, the personal element in the labour, whether depending on nationality or the previous training of the irrigator. Notes are recorded of results obtained in the year preceding the publication of the thesis, the two-way Ewa standard system being employed throughout.

(1) As regards the direction upwards or downwards along the watercourse, a main point to be considered is the consolidation of the soil along the watercourse as irrigation proceeds, with a correlated increasing rapidity of flow and reduction of seepage. The conclusion arrived at appears to be that an alternate irrigation upwards and downwards gives satisfactory results.

(2) The volume of water used per man depends on the permeability of the soil, the character of the cane, and the care taken in previous irrigations of preserving the contours of the channel. Taking a considerable slope and perfectly level land as extremes, flows between 0·3 second-feet and 0·75 are considered most useful; and if anything like the latter quantity is used for land sloping much, the watercourses are ruined and all economical irrigation comes to an end. With soft ridges between the furrows, however, a 50 per cent. reduction would be imperative for at least the first six months. In young canes the channels will be comparatively unobstructed and 0·5 second-feet should not be exceeded, but when the weight of cane approaches 75 tons to the acre this might be increased to 1·0 second-feet, and when there is more cane on the land than this to 1·5.

(3) Proper stripping of the cane is the mark of a good irrigator, who will arrange the dead leaves in small bundles on the side for use as *panis* or temporary dams to regulate the flow when needed. There is, however, a tendency to neglect the stream while engaged in stripping, and to pull off the leaves before they are ready for detachment from the plant. It is found that there is usually time for the treatment of one side of the watercourse during each irrigation, the opposite side being left to the next watering some three

weeks later. In case this is not attended to and the stripping falls a couple of months in arrear, a separate operation will become necessary.

(4) Weeding must never be allowed to cause neglect of the irrigating stream. Slowing the current behind the weeder, which is sometimes done, has its disadvantages; waste of water will occur through seepage and evaporation, and there is danger that the weeds when pulled out may be covered with earth and then wetted, when they will soon sprout again. It is better to allow them to wilt thoroughly before irrigation succeeds weeding.

(5) The age of the cane is, of course, of very obvious influence. At four months an irrigator may cover 1·5 acres in a day, while at 12 months the same man will only be able to deal with 1·0 acre, and at 18 months 0·7.

(6) The class of labour is a vital matter, as it is impossible to supervise, especially in old cane, on a large scale. It is important to interest the irrigator in his work, for instance, by paying a bonus on yield at harvest. But here nationality comes in; such an arrangement will cause a Japanese to put in the best possible work, but the Filipino is not gifted with a two-year vision, and the results will not be known for something like that period of time. Bad habits once indulged in are very difficult to eradicate, so that it is all-important to thoroughly train the irrigator at the start when he can be kept under observation. It is the custom to keep the same man at one watercourse, and with a little intelligence he will soon gauge its peculiarities and know the wet and dry places in its length, and be able to treat them accordingly.

The water pumped up from artesian sources in Hawaii is often more or less brackish, and sometimes markedly so; and the effect of saline irrigation of the sugarcane has from the first naturally attracted much attention. As is well known, the first effect of such irrigation is a paling of the leaves of the cane; with increasing quantities of salt, the leaves become yellow and growth is stunted, and ultimately the leaves become chlorotic and the plant dies outright. Paradoxical as it may seem at first sight, the main remedy is to increase the volume of water given, so as to prevent

any accumulation of the salt in the soil through absorption, which is especially likely when there is the chance of rapid evaporation. The plant appears to be able to take up the salt from the irrigation water with comparative ease, and within limits this is attended with no harmful effects, but when these limits are passed the results are disastrous, both as regards growth and the character of the juice.

Various more or less detached observations and experiments are detailed by the author, those by Maxwell and Eckart being the most fully dealt with. These can only be lightly referred to here. According to Maxwell's observations the danger limit may be considered to be reached when the water contains 0·14 per cent. of salt in solution or 100 grains to the gallon. Eckart observed that saline water renders available from the soil large quantities of lime, magnesia and potash, and points out that, in consequence of this, with the excessive irrigation required when the water is brackish, there is likely to be enormous leaching out and loss of these valuable constituents. For such excessive irrigation to be of use in preventing the accumulation of salt in the upper layers of soil through evaporation, it is necessary for the soil to be porous and drainage to be easy and good. A case is given of an estate with good drainage, which has been watered by salt water for the past 25 years without any ill effects on the cane or increase in the saline constituents of the soil. But when drainage is at all difficult, it soon becomes impossible to use brackish water. Then only temporary relief can be obtained. A mulch of trash, paper, soil, or sand may be added to reduce evaporation to its lowest limit, or the uppermost $\frac{1}{2}$–$\frac{3}{4}$ inches of soil may be bodily removed; such treatment as the latter will, it is claimed, often remove 25–40 per cent. of the total injurious salts in one operation. But these methods do not in any way remove the evil and a thorough washing has sooner or later to be resorted to; and this can only be obtained by washing out the soil at intervals by three or four heavy irrigations with fresh water, which should suffice, and a new start be made. This important subject is, however, very sketchily treated in the thesis, which is mainly concerned with briefly summarizing the results of the more important papers.

The conservation of soil moisture is still more shortly dealt with, less than a page being devoted to it. Three practical methods are referred to: namely, the incorporation of organic matter with the soil to increase its absorptive power, covering the soil with various mulches to reduce evaporation, and the introduction of agricultural practices to prevent the soil drying out. The incorporation of trash is universally condemned in Hawaii and in this matter the experience appears to differ from that in many other sugar-growing countries, and we cannot avoid the suspicion that this view may be partly influenced by the results obtained in the United States, where of course the high temperatures of the tropics are absent and the consequent rapid disintegration of this valuable substance is retarded. A more detailed treatment of this subject would therefore have been welcomed. It is, for instance, mentioned that undecomposed vegetable matter in the soil is not only useless but positively deleterious and Rothamsted results are given in support of this contention. The use of trash as a mulch under irrigation is not extensively practised in Hawaii, the disadvantages being that it covers the young cane and prevents the rapid flow in the water channels; heavy cane, it is noted, provides its own mulch in six months when it covers the ground. The only agricultural practice mentioned is that of planting the cane immediately after making the furrows, the soil not having time to dry out if irrigation does not soon follow.

The application of nitrate of soda and ammonium sulphate in the irrigation water is now a general agricultural practice in the islands, and the method adopted is shown in a figure. For the purpose four barrels are used. Of these one is placed somewhere near the channel and is used thoroughly to dissolve the materials, say 100 lb. to the barrel; two are placed on a staging, one at each side of the channel so that they may be alternately used to keep the actual supplying barrel with liquid of a fixed concentration. This last barrel is immediately over the water channel and is only of half the height of the others (i.e., a half barrel), and the main object of this simple apparatus is that the filling of this fourth barrel is so arranged that the level of the liquid in it is always kept constant,

so that the flow from it to the irrigating stream is unvarying in the amount of fertilizer added per unit of time. The side barrels can be filled alternately from the mixing barrel without difficulty, one being filled while the other is emptying itself. A series of results obtained by observations and experiments are summarized, as in the foregoing sections, on the two pages devoted to the subject, from which it appears that the leaching out of nitrate of soda, which is not retained by the soil, does not appear to be as great in Hawaii as was at one time supposed.

The paper concludes with a series of Tables in which detailed results are recorded where such are available from the papers and experiments referred to.

C. A. B.

Notes

REPORT OF THE FOURTH ALL-INDIA EGG-LAYING TEST.

THE fourth of these competitions took place in the Lucknow Model Poultry Farm under the auspices of the United Provinces Poultry Association.

A record number of entries were received from overseas, 25 from prominent Australian breeders and an equal number from Great Britain's leading utility men.

Unfortunately the Australian birds failed to catch a suitable steamer and their entries have been held over for next cold season when we hope to welcome them here. Altogether 62 birds competed, and we had a clean bill of health throughout the test which reflects great credit on the officers who were responsible at the farm itself.

The birds were fed this year on a slightly different ration to previous years' as we were able to procure fishmeal from the Government fisheries, Madras, and due partly to this fact and doubtless due also to the increasing high producing qualities of birds sent to the test, a very high average of large eggs was gathered, i.e., 3,830 from 62 birds as against 3,592 from 72 birds last year.

The test as far as the Governor's Cup goes, which is given for the highest total of eggs irrespective of weight, was won by Mr. F. R. Welch, Dowles Poultry Farm, Bewdley, England, by his pullet No. 41 laying the extraordinary total of 84 eggs in 92 days. We believe this to be a world record for winter laying, and if so, this will be a sensational achievement. The eggs were, alas, just under standard weight, i.e., $1\frac{3}{4}$ oz., but the pullet was a nicely grown bird and we tried our best to get the larger egg out of her.

The next and in fact the finest record of the test was Mr. Leslie Williams' White Wyandotte pullet No. 45 laying 69·8 eggs. She was a little gem, and many is the demonstration lecture we have given our students at the farm on this hen. We score-carded her

Winner of Governor's Cup (Mr. F. R. Welch's Light Sussex laying 84 eggs in 92 days).

Winner of Overseas Cup (Mr. Leslie Williams' White Wyandotte laying 69 large 2½ oz. eggs).

Winner of U. P. P. A. Stock Cup (Capt. Ansell's R. I. Red laying 65 large eggs).

with many others on Powell Owen's card before the test and she score-carded very high, getting 176 out of a possible 200. She also is a typical Wyandotte and lays 2¼–2½ oz. egg every time. Mrs. Seed's Wyandottes also were of first class quality. Mrs. Grain's Australorps are a nice team and won well. Twenty-one Australorps competed, but Mrs. Grain's ran away from them all and, with the exception of one, all laid good standard eggs. Owing to this hen Mrs. Grain lost the Dewar Team Cup which went to Mr. Bradbury, England.

Very few Rhode Island Reds competed and this is a pity as the breed is equal to any other for winter laying. The U. P. Poultry Association pullet No. 76 bred on the farm and owned by Capt. Ansell, who has gone to Burma, put up a record of 65 eggs, laying only one second grade egg during the test.

The following is a full detailed list of the record of each hen :—

Owner	Breed	Pen No.	Gross total eggs laid	Total to score	Remarks The awards were based on the number of first and second grade eggs and 20 per cent. of second grade were cut from the score.
Australorps Farm, Ltd., England	Austral Orpington	25	21	21·0	These birds had large eggs but took a long time to lay, being in too fat a condition on arrival.
	,, ,,	26	44	41·8	
	,, ,,	27	41	41·0	
	,, ,,	28	41	40·2	
Stanley Street Porter, England	White Leghorn	29	44	40·2	Did a partial moult.
	,, ,,	30	22	19·4	
	,, Wyandotte	31	63	50·2	
	,, ,,	32	61	49·2	
Misses Ransford, England	White Leghorn	33	66	61·2	These two were a little immature or would have done better.
	,, ,,	34	61	58·8	
Major Dugdale, England	White Leghorn	35	25	24·4	
	,, ,,	36	46	45·2	
	Light Sussex	37	53	52·8	
F. R. Welch, England	Light Sussex	39	41	34·2	
	,, ,,	40	52	44·2	
	,, ,,	41	84	67·2	Governor's Cup and Best Consecutive Layer.
	,, ,,	42	37	36·8	
Leslie Williams, England	White Wyandotte	43	64	58·6	Broody.
	,, ,,	44	22	22·0	
	,, ,,	45	70	69·8	Overseas Cup and Best Heavy Breed Layer.
	,, ,,	46	14	11·2	Moulted.

Owner	Breed	Pen No.	Gross total eggs laid	Total to score	Remarks
Capt. Greenway, England	R. I. Red	47	17	17·0	Arrived sick.
W. Bradbury, England	White Leghorn	49	42	40·0	
	,, ,,	50	62	61·6	Best Team of Birds. No. 50
	Light Sussex	51	63	63·0	Best Light Breed Layer.
	,, ,,	52	57	56·0	
Mrs. Grain, Ranikhet	Austral Orpington	53	67	66·6	Best Layer from India. Best Australorp Breed Layer, and Best Poultry Club Layer.
	,, ,,	54	60	59·0	
	,, ,,	55	47	45·4	
	,, ,,	56	60	48·2	
Capt. Mayn, Nahan	White Leghorn	57	35	29·6	
	,, ,,	58	31	29·2	
	,, ,,	59	57	54·8	
	,, ,,	60	57	53·2	
Mrs. Richardson, Nahan	Austral Orpington	61	29	28·2	These birds were over fat and had been forced on too much beforehand.
	,, ,,	62	18	14·4	
	,, ,,	63	5	4·0	
	,, ,,	64	19	15·2	
English Poultry Farm, Karachi	Austral Orpington	65	56	48·0	
	,, ,,	66	27	22·2	
	,, ,,	67	46	37·0	
	,, ,,	68	42	35·4	
E. Caston, Gorakhpore	Austral Orpington	69	60	51·0	
A. C. Bullmore Madras	Austral Orpington	70	55	52·0	
	,, ,,	71	36	35·6	
	White Leghorn	72	49	48·6	
	,, ,,	73	52	51·8	
Kalaw Poultry Farm, Burma	R. I. Red	74	46	41·2	
	,, ,,	76	65	64·8	U. P. Poultry Association stock special.
Mrs. Cardew, Bareilly	White Orpington	78	64	58·4	
	,, ,,	79	42	41·4	
Mr. Burnside, Ghazipore	Cross-breed	80	44	35·2	
	,, ,,	81	45	36·6	
	,, ,,	82	49	44·2	
Raja of Mursan, U. P.	Light Sussex	83	51	49·2	Best Indian Owned.
	,, ,,	84	58	44·8	
	Rose Combed Bl. Minorca	85	56	44·8	
Mrs. Seed, England	White Wyandotte	91	68	65·0	
	,, ,,	92	72	63·2	

All birds laying over 50 first grade eggs have been awarded a special certificate

List of Special Prize Winners.

1. The Governor's Cup presented by His Excellency the Governor, U. P., won by a Light Sussex pullet with a score of 84 eggs in 92 days, owned by Mr. F. R. Welch, England.

2. Best layer from overseas, Cup presented by the Stewards of Lucknow Races, won by a White Wyandotte pullet with a score of 69 4/5 eggs, all over standard weight, owned by Mr. Leslie Williams, England.

3. Best layer from India, presented by the Stewards of Lucknow Races, won by a Black Australorp pullet with 66 3/5 eggs, all standard weight, belonging to Mrs. Grain, Ranikhet.

4. Best team of birds. Cup presented by the Right Hon'ble Lord Dewar, won by four pullets owned by Mr. Bradbury, with 220·6 eggs.

5. Cup for the best layer bred or purchased from the U. P. Poultry Association farm. Cup presented by the U. P. Poultry Association, won by a Rhode Island Red pullet, with 64 4/5 standard weight eggs, owned by Capt. Ansell, Kalaw Poultry Farm, Kalaw, Burma.

6. Cup for the best layer heavy breed, presented by the Raja of Mursan, won by the same as No. 2.

7. Cup for the best layer light breed, presented by Messrs. Perry & Co., Lucknow, won by Mr. Bradbury's White Leghorn pullet.

8. Best layer owned by an Indian resident of the United Provinces, won by Raja of Mursan's Light Sussex pullet.

9. Best consecutive layer, presented by the U. P. Poultry Association, won by the same as No. 1 laying 26 eggs consecutively.

10. Best layer belonging to a member of the Indian Poultry Club, presented by the Indian Poultry Club, won by Mrs. Grain's Australorp pullet.

11. Best layer Australorp breed, presented by the Austral Orpington Club, England, owned by a Club member, won by Mrs. Grain, Ranikhet. [Mrs. A. K. Fawkes.]

A FREAK BULLOCK.

A BULLOCK of the Malvi breed belonging to the Bombay Municipality was brought to the hospital of the Bombay Veterinary College for clinical demonstration in December 1923. The case was a very interesting one by reason of the animal having, besides the male genital organs, a well developed udder with four rudimentary teats.

The bullock yields milk throughout the year from all the four teats to the extent of two to four ounces daily. It will be seen from the accompanying photographs that the animal has been

FIG. 1.

FIG. 2.

mulled * and the sheath is quite prominent, while the udder is as well developed as in many milch cows, the teats also being fairly large. Female genital organs are entirely absent. [H. A. IDNANI.]

***

RESEARCH FACILITIES FOR STUDENTS AT ROTHAMSTED.

WE. have received the following from the Director of the Rothamsted Experimental Station:—

I wish to bring to your notice the facilities offered by the Rothamsted Experimental Station in respect of the research degrees of Cambridge and London Universities, and I would be much obliged if, in future, post-graduate workers, scholarship holders, etc., could have these facilities brought to their notice. We would like to reach not only those who have attended agricultural colleges, but also workers in pure science, as many investigations not directly connected with agriculture can be profitably pursued in an agricultural environment.

The Station comprises laboratories in which research work in the following subjects may be done: - Physics with physical-chemistry, chemistry, insecticides and fungicides, fermentation, botany, bacteriology, protozoology, mycology, algology, entomology, statistics, technique of field experiments.

The Station does not investigate problems outside the study of soil and the growing plant in health and disease; i.e., no work is done on plant breeding, animal nutrition, agricultural economics, etc. The laboratories have been completely rebuilt within the past 10 years, and the library containing books on agriculture and agricultural science is acknowledged to be one of the most complete in the world. The permanent scientific staff numbers about 40, and at the moment there are 7 post-graduate workers, scholarship holders, etc., conducting research work for the higher degrees mentioned in the enclosed circular.

No personal fees or charges are made to voluntary workers in respect of the use of facilities and the supervision of their work

* Mulling is a method of castration by beating between the boards, practised by unqualified Indian castrators.

by the head of the department. Owing, however, to the high cost of apparatus and chemicals, the Station may ask in the case of workers sent here by Colonial Governments, Universities, Institutions, etc., for a contribution from these authorities in respect of these charges.

Research Degrees of Cambridge and London Universities.

The *University of Cambridge* is prepared to give favourable consideration to each individual case of applicants who desire to carry out at Rothamsted a portion of their work for the following Degrees:—M.Sc., Ph.D.

The *University of London* has accepted the Rothamsted Experimental Station as a "Recognized Institution" from which research workers may submit work done at Rothamsted for the following degrees:—M.Sc., Ph.D., D.Sc.

A brief precis of the most important conditions that must be fulfilled by candidates is given below for general guidance.

Intending workers at Rothamsted are strongly advised in the first instance to send a full account of their academic qualifications and training to the Director, as the candidate will be allowed to enter his thesis only if these qualifications are acceptable to the University Senate.

The general conditions imposed by the University regulations are briefly:—

(1) *Cambridge.* These degrees are granted in full to men only; under certain limitations the titles of degrees are open to women without the privileges which the degree confers in the University.

M.Sc. A minimum residence of five terms at Cambridge and one at Rothamsted. Thesis to be presented not earlier than sixth and not later than twelfth term from term of admission as a research student.

Ph.D. A minimum residence of six terms at Cambridge and three at Rothamsted. Thesis normally to be presented not earlier than ninth term and not later

than twelfth term from term of admission as a research student. In special cases permission may be sought to present the thesis after the sixth term.

NOTE.—Three consecutive terms at Cambridge constitute a year.

(2) *London.* These degrees are open to men and women on equal terms.

M.Sc. and Ph.D. A minimum residence of two calendar years at Rothamsted before submission of the thesis.

D.Sc. Normally the candidate must first hold the M.Sc. degree of the University, but in special cases, on the ground of published work, this regulation may on application be waived. A residence of two years at Rothamsted is required.

A student must ordinarily have taken his first degree not less than four years before the date of his entry for the D.Sc. examination.

NOTE.—In the case of students registering in October the two-year period may be regarded as ending in the June of the second year.

In the case of workers already holding a first degree of London University, they may enter as external students for higher degrees without any requirements as to residence.

***

POST-GRADUATE TRAINING AT THE PUSA INSTITUTE.

In a Press Communique issued on the 22nd June, 1923, the Government of India announced the institution of post-graduate courses for specialists in certain subjects at the Agricultural Research Institute and College, Pusa, and stated that these courses would be confined to distinguished graduates of Universities or Agricultural Colleges and also to students who had undergone training in agriculture and its allied branches in British Universities or in one of the recognized Agricultural Colleges and who possessed suitable qualifications. They have now decided to throw these courses open also to selected officers of the Provincial Agricultural Service provided they are fully qualified to take advantage of them and are

recommended by the Government of the Province in which they may be serving. The first course commenced on the 1st November, 1923, and subsequent courses will commence from about the same date annually. The training will last for two years. Applications for further particulars regarding the courses, fees chargeable, etc., should be made to the Director and Principal, Agricultural Research Institute and College, Pusa.

No guarantee of appointment to the Indian Agricultural Service is given to the officers who pass through the training successfully.

***

THE WORLD'S WHEAT POSITION.

THE harvests of autumn 1922 were very poor in the importing countries of the world, and especially on the Continent of Europe; and yet, owing no doubt to the general impoverishment and the depreciation in the currencies of most European countries, Europe imported net during the cereal year ending with July 31st, 1923, only about the same quantity of wheat which she imported in the previous year, namely, 69 million quarters. (Before the war, when Russia was exporting wheat, Europe's net demand from abroad averaged only 36 million quarters.) Putting together the statistics for all the importing countries of the world, their net import during the last cereal year was 87 million quarters, as compared with 84 in the previous year, and with the pre-war average net import of 82.

Harvests better this year. The harvests of this autumn have been very much better than those of last year, and (including rough estimates for the coming harvests of the Southern Hemisphere and India) the prospects are that during the current cereal year ending with July 31st, 1924, the yield of all the countries, both importing and exporting, for which statistics were available (not including Russia), will be 430 million quarters, as compared with 388 last year, and with the pre-war average of 372. For the countries of Europe, both importing and exporting (excluding Russia), the total yield during the harvest just ended has been 160 million quarters, as

compared with 130 last year, and with 169 before the war; so that if Europe required for consumption during the current cereal year only the same total quantity of wheat as she consumed last year, she would have to import 30 million quarters less this year than she did last year. Britain, however, which is the chief importer, does not seem likely to reduce her demand for foreign wheat (estimated at 28 million quarters), and, owing to the better harvests on the Continent and the fall in prices, several of the Continental countries may increase their consumption. After allowing for the special circumstances of each country, I estimate that the net demand of Europe from abroad during the current year will be only 53 million quarters, as compared with the 69 million quarters she actually imported from abroad during the last cereal year. Allowing 19 million quarters as the total demand of the importing countries outside Europe, I reckon the total demand of all the importing countries in the world as likely to be 80 million quarters, as compared with the 87 million actually imported last year.

The exporting countries of the world (excluding Russia) have also had a considerably better yield than they had last year, and are likely to have available for export, during the current cereal year ending with July 1924, a total surplus of 132 million quarters, including the 24 million quarters of exportable surplus they carried over on August 1st last. If these estimates turn out to be correct, then on August 1st next the exporting countries of the world are likely still to have in their hands about 52 million quarters of exportable old wheat—enough in itself to meet the probable demand of the importing countries for seven months without drawing on the produce of the harvests to be reaped after August 1st next.

Further fall in prices predicted. During the last twelve months the growing prospect of an accumulation of exportable wheat has led to a considerable fall in the world price of wheat, and the average price at Liverpool of foreign wheat is at present about 14 per cent. below what it was twelve months ago, but is still 18 per cent. above what it was on the average for 1913. In England

and Wales, on the average price obtained by farmers for their wheat, according to the Corn Returns, was 33*s.* 4*d.* per 480 lb. For the week ending October 27th, the average prices were in 1913, 30*s.*; in 1922, 41*s.* 6*d.*; in 1923, 39*s.*; so that the price now obtained by farmers is about 6 per cent. below the price they were getting last year, but is still 30 per cent. above the price in the corresponding week in 1913. As the Index Number of wholesale prices in this country is about 50 per cent. above the level of 1913 and the cost of living (on which wages largely depend) is 75 per cent. above the level of July 1914, it is little wonder that many farmers no longer find it profitable to grow wheat, except on land specially suited for that crop. This state of things must tend to a further reduction in the area sown with wheat in this country.

No likelihood of scarcity for two years. The probable gradual increase in the world's surplus of exportable wheat, for which market cannot be found at present prices and the consequent competition between the five principal exporting countries, all of which have considerable surpluses to dispose of, must tend to a further fall in the world's price of wheat in the near future. Such a fall would in its turn tend to a reduction in the area sown with wheat; but, so far, except in Great Britain and perhaps in the United States, the indications are that the area under wheat next harvest will be larger than this year and unless the weather proves very unfavourable for the world as a whole, there is no likelihood of a scarcity of wheat during the next two years.

British Empire more than self-supporting. Before the war the British Empire was not self-sufficient as regards wheat the net imports having on the average of five years exceeded the net exports by some 6 million quarters; but in each of the last three cereal years its net exports have exceeded its net imports, and last year the three exporting countries of the Empire (Canada, Australia and India) actually exported 15 million quarters more than were imported by the importing countries of the Empire (United Kingdom, South Africa, and other overseas possessions). During the current cereal year, thanks mainly to Canada's excellent crop, the surplus available for export in the three exporting countries is likely to be

large enough to supply all the importing countries of the Empire with more than double the quantity of wheat they will require to import - the estimated surplus available for export being 69 million quarters, while the total imports of the importing countries of the Empire are not likely to exceed 33 million quarters. It seems practically certain that for many years to come the Empire will grow much more wheat than it itself requires, and will have a large surplus to spare for export to foreign countries. Probably it is also more than self-sufficient as regards barley, oats, rice and potatoes. [SIR JAMES WILSON in *Empire Production and Export*, No. 89.]

***

RESTRICTIONS ON IMPORT OF PLANTS FROM INDIA INTO ENGLAND, WALES AND IRELAND.

THE following notification, dated 29th February, 1924, has been issued by the Government of India in the Department of Education, Health and Lands: -

Under the recent Destructive Insects and Pests Orders made by the Agricultural Departments of England, Northern Ireland and the Irish Free State, the importation from India into England, Wales and Ireland of any of the plants mentioned in Appendix I is permitted in accordance with the following regulations.

Each consignment should be accompanied by two copies of a certificate in the form prescribed (Appendix II) issued after inspection, not more than 14 days prior to the date of shipment, by a duly authorized official of the country of export, to the effect that the consignment is healthy and free from the plant diseases, insects and pests named in the second schedule (reproduced in Appendix III) to the Orders mentioned. Plants will not be deemed to be healthy which are attacked by any insect or pest mentioned in Appendix IV. One copy of the certificate should be produced to the Customs officer at the port of entry, except in the case of consignments imported through the post when the copy should be affixed to each package, and the other copy forwarded by the importer to the consignee. The original of the certificate should be forwarded by post, before the plants are despatched, by the

exporter to one of the undermentioned addresses according to the destination of the consignment.

England and Wales. The Horticulture Division of the Ministry of Agriculture and Fisheries, Whitehall Place, London.

Irish Free State. The Secretary, Department of Agriculture and Technical Instruction for Ireland, Upper Merrion Street, Dublin.

Northern Ireland. Minister of Agriculture, Northern Ireland, Belfast.

The import into the Irish Free State of potatoes, other than potatoes landed before the 15th of July in the year in which they were lifted and gooseberry or currant bushes, is not permitted without a license previously obtained by the consignee. Exporters are, therefore, advised to assure themselves that these licenses have been procured before forwarding such consignments.

A consignment of imported plants which is not accompanied by certificates in the prescribed form will be detained before delivery pending inspection, and disinfection if necessary, by an officer deputed for the purpose, the charge for whose services and all incidental expenditure will be defrayed by the importer.

2. In the interests of exporters in this country facilities for the grant of the prescribed certificates have been provided in the provinces and Indian States noted below, and the arrangements adopted by them are published for general information.

Madras. Consignments should be sent to the Agricultural College, Coimbatore, whence after examination they will be sent to any desired port in the Madras Presidency for export. No charge will be made for actual examination and grant of certificates, but all incidental expenses, such as carriage and cost of repacking after examination, will be defrayed by the persons applying for the certificates.

Bombay. Consignments should be sent to the Agricultural College, Poona, where inspection and certification will be made free of cost, provided that all incidental charges are borne by the exporters.

Punjab. Consignments should be sent to the Agricultural College, Lyallpur, for necessary examination and certification.

Burma. Persons desirous of exporting plants from Rangoon should apply to the Assistant Botanist, Hmawbi, who will grant the required certificates after suitable examination of consignments.

Central Provinces. Exporters will be required to present plants for inspection by a Deputy Director of Agriculture in the province or by the Economic Botanist, Nagpur, who will be authorized to issue the necessary certificates.

Mysore. Consignments should be sent to the office of the Director of Agriculture, Mysore, where the necessary certificates will be signed by the Director on the basis of an examination made by competent mycological and entomological officers. No charges, other than incidental charges, will be imposed at present.

Travancore. Consignments should be sent to the office of the Director of Agriculture and Fisheries, Quilon, whence after examination they may be sent to any desired port for despatch. No charge will be made for examination and grant of certificates, but all incidental expenses such as carriage and cost of re-packing after examination will be defrayed by the persons applying for the certificates.

Suitable facilities for examination and the issue of the prescribed certificates are not available in other parts of British India and in the other Indian States.

Appendix I.

(*a*) All living plants with a persistent woody stem above ground, and parts of the same, except seeds, when for use in propagation—such as fruit trees, stocks and stools, forest trees, and ornamental shrubs and grafts, layers and cuttings thereof.

(*b*) All potatoes; and all tubers, bulbs, rhizomes, corms, and hop stocks for planting.

(*c*) Seeds of onions and of leeks for sowing.

(*d*) Gooseberries.

Appendix II.

Certificate of examination of Plants, No.

This is to certify that the plants included in the package or consignment described below were thoroughly inspected by , a duly authorized official of , on , and were found or believed by him to be healthy and free from any of the plant diseases or pests named in the second schedule to the Destructive Insects and Pests Order of 1922.

This additional certificate must be given for all potatoes:

Further, it is hereby certified that no case of the disease known as Wart Disease or Black Scab of Potatoes (*Synchytrium endobioticum*) has occurred on the farm or holding where the potatoes included in this consignment were grown nor within 500 yards (approximately $\frac{1}{2}$ kilometre) thereof.

(Signed).....

(Official Status).....

The following details must be filled in by the shipper:

Number and description of packages in consignment.....
Distinguishing marks .....
Description of plants .....
Grown at .....
Name and address of exporter .....
Name and address of consignee .....
Name of vessel .....
Date of shipment .....
Port of shipment .....
Port of landing in England, Wales or Ireland.....
Approximate date of landing.....

(Signed) .....

Appendix III.

Fungi—

Black Knot of Plum and Cherry (*Plowrightia morbosa*, Sacc.).
Fire or Pear Blight (*Bacillus amylovorus*, Trev.).

Chestnut Canker (*Endothia parasitica*, [Murr.] Ander. and Ander.).

Wart Disease or Black Scab of Potatoes (*Synchytrium endobioticum* Perc.).

Onion and Leek Smut (*Urocystis cepula*, Frost).

Downy Mildew of Hops (*Peronoplasmopara humuli*, Miy. et Taka.).

Insects -

Vine Louse (*Phylloxera vastatrix*, Planch.).

American Apple Capsids (*Heterocordylus malinus*, Reut., and *Lygidea mendax*, Reut.).

Pear Tingid (*Stephanitis pyri*, Fab.).

Colorado Beetle (*Leptinotarsa decemlineata*, Say.).

Plum Curculio (*Conotrachelus nenuphar*, Herbst.).

Potato Moth (*Phthorimæa operculella* Zell.).

American Lackey Moths (*Malacosoma americana*, Fab., and *M. disstria*, Hubn.).

Oriental Fruit Moth (*Cydia molesta*, Busck.).

San José Scale (*Aspidiotus perniciosus*, Comst.).

Japanese Fruit Scale (*Diaspis pentagona*, Newst.).

Apple Fruit Fly (*Rhagoletis pomonella*, Welsh).

Cherry Fruit Flies (*Rhagoletis cerasi*, Linn., *R. cingulata*, Loew and *R. fausta*, Osten Saken).

Gooseberry Fruit Fly (*Epochra canadensis*, Loew.).

Appendix IV.

A. *Fruit and other Tree Pests*

Fruit Tree Cankers (produced by *Nectria ditissima*, Tul., or any species of *Monilia*).

Silver Leaf (*Stereum purpureum*, Pers.).

Black Currant Mite (*Eriophyes ribis*, Nal.).

Woolly Aphis (*Eriosoma lanigerum*, Hausm.).

All Scale insects (*Coccidæ*.).

Brown Tail Moth (*Nygmia Phæorrhœa*, Don.). (*Euproctis chrysorrhœa*.)

Rhododendron Fly (*Leptobyrsa* [*Stephanitis*] *rhododendri*, Horv.)

American Gooseberry Mildew (*Sphærotheca morsuva*, Berk.).

B. *Vegetable and Root Pests*

Corky or Powdery Scab of Potatoes (*Spongospora subterranea*, Lagerh.).

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

Mr. G. S. Bajpai, I.C.S., has been appointed to officiate as Deputy Secretary to the Government of India, Department of Education, Health and Lands, *vice* Mr. R. B. Ewbank, I.C.S., on other duty.

***

Dr. W. H. Harrison, D.Sc., Imperial Agricultural Chemist, has been appointed substantively Joint Director of the Agricultural Research Institute, Pusa.

***

Mr. A. Howard, C.I.E., M.A., Imperial Economic Botanist, Pusa, has been granted leave on average pay for 7 months and 3 days from 17th March, 1924. Dr. F. J. F. Shaw officiating until 15th April, 1924.

***

Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist, Pusa, has been granted combined leave for 7 months and 9 days from 11th March, 1924.

***

The University of Edinburgh has conferred the degree of D.Sc. on Mr. W. McRae, M.A., B.Sc., officiating Imperial Mycologist, Pusa.

***

Dr. J. Sen, M.A., Ph.D., Supernumerary Agricultural Chemist, Pusa, has been appointed to officiate as Forest Chemist, Forest Research Institute and College, Dehra Dun, for 8 months, from 7th April, 1924.

***

Mr. B. C. Burt, M.B.E., B.Sc., Secretary, Indian Central Cotton Committee, Bombay, has been granted leave on average

pay for 7 months from 3rd April, 1924, Mr. G. R. Hilson, B.Sc., officiating.

***

Mr. M. B. Menon, G.B.V.C., has been appointed to officiate as Third Bacteriologist, Imperial Bacteriological Laboratory, Muktesar, for 1 year from 15th March, 1924, *vice* Mr. T. M. Timoney, M.R.C.V.S., resigned.

***

Mr. M. Carbery, M.A., B.Sc., Agricultural Chemist to the Government of Bengal, has been confirmed in the Indian Agricultural Service from 11th March, 1924.

***

Mr. F. Smith, B.Sc., Deputy Director of Agriculture, Bengal, on return from leave, has been posted to the Eastern Circle from 15th March, 1924.

***

Mr. R. T. Davis, M.R.C.V.S., Offg. Director, Civil Veterinary Department, Bengal, was on leave on average pay for 1 month from 1st April, 1924, Mr. A. D. McGregor, M.R.C.V.S., officiating.

***

Mr. F. R. Parnell, M.A., Government Economic Botanist, Madras, has been granted combined leave for 2 years, 2 months and 18 days from or after 10th March, 1924. Mr. K. Ramiah has been placed in charge of the office until further orders.

***

Mr. R. C. Broadfoot, N.D.A., has been appointed to officiate as Cotton Specialist, Madras, *vice* Mr. G. R. Hilson on other duty, and also as Principal of the Agricultural College and Research Institute, Coimbatore, *vice* Mr. F. R. Parnell granted leave.

***

Mr. Sadaat Ullah Khan, M.A., B.Sc., Deputy Director of Agriculture under training, has been placed in charge of the VI Circle, Madras, *vice* Mr. R. C. Broadfoot on other duty.

Mr. D. G. Munro, B.Sc., has been confirmed in the Indian Agricultural Service as Deputy Director of Agriculture, Madras, from 4th December, 1923.

***

Dr. Harold H. Mann, D.Sc., has been confirmed as Director of Agriculture, Bombay, from the date of retirement of Mr. G. F. Keatinge, I.C.S.

***

Mr. P. C. Patil, M.Sc., L.Ag., Deputy Director of Agriculture, South Central Division, Bombay, has been granted leave on average pay for 1 month and 10 days, Mr. K. M. Pawar officiating.

***

Mr. E. S. Farbrother, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bombay, has been granted leave on average pay for 7 months from 15th April, 1924. Khan Saheb J. D. Buxy, G.B.V.C., officiating.

***

Mr. C. H. Parr, B.Sc., Deputy Director of Agriculture in charge of Cattle-breeding, United Provinces, has been granted leave on average pay for 5 months from 15th May, 1924.

***

Mr. A. C. Dobbs, B.A., Director of Agriculture, Bihar and Orissa, has been placed on special duty for 2 weeks from 14th April, 1924, and granted leave on average pay from 28th April to 1st October, 1924, Mr. G. S. Henderson officiating.

***

Mr. G. C. Sherrard, B.A., Deputy Director of Agriculture, Patna Circle, Bihar and Orissa, has been granted leave on average pay from 8th April to 1st October, 1924. Mr. H. L. Datta officiating.

***

Mr. N. S. McGowan, B.A., Professor of Agriculture in charge of District Work, Bhagalpur Circle, Bihar and Orissa, has been

granted leave on average pay for 6 months from 2nd April, 1924.

***

CHAUDHURI MUHAMMAD ABDULLA, Deputy Director of Agriculture, Punjab, and SARDAR SAHIB KHARAK SINGH, M.A., Associate Professor of Agriculture, Lyallpur, have been confirmed in the Indian Agricultural Service.

***

MIAN MUKHTAR NABI, Extra Assistant Director of Agriculture, Gurdaspur, assumed additional charge of the duties of Deputy Director of Agriculture, First Circle, Punjab, on 31st January, 1924, relieving Malik Sultan Ali who proceeded on leave for 4 months.

***

RAI SAHIB LALA JAI CHAND LUTHRA, M.Sc., Associate Professor of Botany, assumed charge of the post of Economic Botanist to Government, Punjab, in addition to his own duties, from 16th February, 1924, relieving Agha Yusuf Ali Khan deputed to England in connection with the British Empire Exhibition.

***

MR. S. R. RIPPON, M.R.C.V.S., who has been appointed to the Indian Veterinary Service, has been posted to Burma.

***

MR. J. H. RITCHIE, M.A., B.Sc., Deputy Director of Agriculture, Northern Circle, Central Provinces, has been granted leave on average pay for 8 months from 1st April, 1924. Mr. R. H. Hill officiating.

***

MR. S. T. D. WALLACE, B.Sc., Deputy Director of Agriculture in charge of Animal Husbandry, Central Provinces, has been granted combined leave for 7½ months from 22nd April, 1924. Mr. J. C. McDougall officiating in addition to his own duties in charge of the Southern Circle.

MR. S. G. MUTKEKAR, M.Sc., B.Ag., Officiating Deputy Director of Agriculture, Western Circle, Central Provinces, has been granted leave on average pay for 1 month from 22nd April, 1924, Rai Sahib Bhayya Lal Dube officiating.

***

MR. J. F. DASTUR, M.Sc., D.I.C., Mycologist to Government of Central Provinces, was on leave on average pay from 24th March to 17th April, 1924, Mr. K. P. Shrivastava officiating.

***

MR. E. A. H. CHURCHILL, B.Sc., Assistant Director of Agriculture, Jubbulpore, has been transferred in the same capacity to Chhindwara, Central Provinces.

***

RAI SAHIB TUNDILAL PAWAR has been appointed to officiate as Deputy Director of Agriculture, Eastern Circle, Central Provinces, *vice* Mr. J. C. McDougall on other duty.

NOTICE

THE undersigned is about to prepare a complete record of the students trained at the Agricultural Research Institute, Pusa. The record will contain the following information regarding the career of each :—

(1) Name of student.
(2) Province or State from which he came.
(3) Kind of training given.
(4) Employment obtained after being trained.

Old students of the Institute are requested to assist in the preparation of this record by supplying the undersigned with the information asked for above.

D. CLOUSTON,

Offg. Agricultural Adviser to the Government of India.

Reviews

THREE BOOKS ON ENTOMOLOGY.

(1) **Animal Parasites and Human Disease.**—By ASA C. CHANDLER; Second Edition, Revised, 1922, Chapman and Hall; Price, 22*s*.

(2) **The Principles of Insect Control.**—By R. A. WARDLE and P. BUCKLE; 1923; Longmans, Green & Co.; Price, 20*s*.

3) **Social Life among the Insects.**—By W. M. WHEELER; 1923; Constable and Co.

(1) That this book has reached a second edition shows that it has met a want. It is a very well-written and well-balanced *résumé* of our present knowledge of those Human Diseases, which are caused directly or indirectly by Protozoa, Worms and Arthropods—diseases which are of very direct interest to all the human race, especially to those living in warm climates, where the labour-outturn of the cultivator is normally reduced to a serious extent by such diseases as hookworm and malaria. For the entomological and veterinary worker in India, no less than to the medical man, this book provides a concise and accurate summary of the subject dealt with. It contains a few errors, which will doubtless be corrected in a later edition; some of these are mere slips but others, such as the statement (p. 485) that *Pangonia* sucks blood while hovering in the air, are errors of fact which have already been corrected in print.

(2) The vast output of literature on Economic Entomology makes it increasingly difficult for workers in this line to keep themselves informed of past and recent progress in this subject throughout the World. The *Review of Applied Entomology*, it is true, abstracts all current literature very usefully but serves rather as an Index than a classified abstract of recent literature. The present volume,

therefore, meets a real want by providing under one cover a *résumé* of recent literature on methods of Insect Control. That such an attempt to cover an enormous field has resulted in an elimination of all errors or in the inclusion of every control-method which has been advocated, would be too much to expect; but within its limits this compilation will be found very useful to all economic workers and should certainly find a place in the library of every Agricultural College in India. The book is divided into four parts. Part I deals with Biological Control under the heads of Host Resistance, Climatic Restraints, Disease, Parasites and Predators, and Bird Encouragement. Part II deals with Chemical Control by means of Insecticides (three chapters), Dips and Dressings, Attractants and Repellents, and Fumigants. In Part III we come to Mechanical Control by Cultural Methods, Restriction of Spread, Crop Storage, and Baits and Traps, whilst Part IV gives a summary of Legislation for the control of pests, and an Appendix includes an account of machinery for spraying and dusting.

On page 2 the authors state that the San José scale "attacks all fruit trees except chestnut, fig, cherry and vine": in Kashmir both cherry and vine were found to be attacked in 1923 and cherry has also been recorded as attacked in California. On page 9 Oshima is quoted as stating that teak is absolutely immune to termites; this may be so in Formosa but requires qualification as a general statement; teak is not immune in India and in Java Dammerman has described *Kalotermes tectonæ* which attacks living teak trees.

Under the heading of Attractants, the authors might have made some mention of the Andres-Maire form of trap, which has been used with success in India for the control of *Agrotis ypsilon*. So far as Indian workers are concerned, indeed, a noticeable point in this book is the very infrequent reference made to Indian publications on Economic Entomology. Most of the methods described in Chapter XIII, under Restriction of Spread of Pests, are based on work in Europe and America. As this book should be equally valuable to workers in the Tropics, the utility of subsequent editions will be improved by the addition of notes on control-methods found useful there.

(3) Professor Wheeler is a well-known authority upon the Ants, which are amongst the best-known exponents of social life amongst the Insects. This book reproduces six lectures which were given at the Lowell Institute in 1922, and will be found equally interesting to the entomologist and to those who are interested in the habits of insects without necessarily wishing to enter into such subjects as their classification and nomenclature. It is perhaps difficult to make a strict definition of social insects. In this book Professor Wheeler includes in this category Beetles, Wasps, Bees, Ants, Earwigs, Embiads and Termites, and to these a slight extension of the line would add some Crickets, Moths and Bugs. [T. B. F.]

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Poultry Farming in the East.—By MRS. A. K. FAWKES, Poultry Expert to the Government of United Provinces. (Allahabad: Pioneer Press.) Price, Rs. 4.

MRS. FAWKES has produced an excellent little handbook on poultry farming in India. She has managed to adapt to Indian conditions many of the principles of successful fowl keeping as practised in the West.

The chapter on housing is particularly good; as the author says, "most of the failures in poultry keeping in India are attributable to one factor and that is that people will house their fowls in an empty godown in the compound."

The section on diseases is full but clear, though the amateur will be well advised to spend more time in preventative measures than in applying remedies after disease has broken out.

The egg-laying competitions at Lucknow have been valuable in bringing public attention to possibilities of poultry keeping in India.

Feeding is another section which will well repay careful attention. A suitable and well balanced ration is of the greatest importance.

The book is well got up and is full of useful information. It can be thoroughly recommended to any one interested in poultry and the author is to be congratulated on her book. [G. S. H.]

NEW BOOKS

ON AGRICULTURE AND ALLIED SUBJECTS

1. The New Agriculture, by Kary C. Davis. Pp. 494. (Philadelphia and London : J. B. Lippincott Co.) Price, 8*s*. 6*d*. net.
2. The Co-operative Marketing of Farm Products, by O. B. Jesness. Pp. xiii+292. (Philadelphia and London : J. B. Lippincott Co.) Price, 10*s*. 6*d*. net.
3. The Nature and Properties of Soils ; A College Text of Edaphology, by T. Lyttleton Lyon and Harry O. Buckman. Pp. v+588. (London : Macmillan & Co.) Price, 15*s*. net.
4. The Principles of Agriculture, by J. R. Ainsworth-Davis. Pp. xiv+261. (London : Methuen & Co.) Price, 7*s*. net.
5. Practical Botany for Indian Students, by Diwan Bahadur K. Rangachariar, M.A., L.T. (Madras : Superintendent, Government Press.)
6. Social Life in the Insect World, by J. H. Fabre. Translated by Bernard Miall. (London : T. Fisher Unwin, Ltd.) Price, 8*s*. 6*d*. net.
7. Animal Nutrition, by T. B. Wood, C.B.E., M.A., F.I.C., F.R.S. (London : University Tutorial Press, Ltd.) Price, 4*s*. 6*d*.

THE following publications have been issued by the Imperial Department of Agriculture in India since our last issue :—

Memoir.

1. Studies in Gujarat Cottons. Part II, by Maganlal L. Patel, B.AG. (Botanical Series, Vol. XII, No. 5.) Price, R. 1-12 or 3*s*.

Reports.

2. Proceedings of the Board of Agriculture in India held at Bangalore on the 21st January, 1924, and following days (with appendices). Price, R. 1.
3. Proceedings of the Cattle Conference held at Bangalore on 22nd and 23rd January, 1924 (with appendices). Price, As. 9.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1ST AUGUST 1923 TO THE 31ST JANUARY 1924.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*The Agricultural Journal of India*, Vol. XVIII, Parts V and VI, and Vol. XIX, Part I. Price, R 1-8 or 2*s.* per part; annual subscription Rs. 6 or 9*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India.	Messrs. Thacker, Spink & Co., Calcutta.
2	Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert and the Secretary, Sugar Bureau), for 1922-23. Price, R. 1.	Issued from the Agricultural Research Institute, Pusa.	Government Printing, India, Calcutta.
3	Review of Agricultural Operations in India, 1922-23. Price, R. 1-10.	Agricultural Adviser to the Government of India.	Ditto
4	A Study of the Factors operative in the value of Green Manure. Pusa Agricultural Research Institute Bulletin No. 149. Price, As. 5.	B. H. Wilsdon, M.A., I.E.S., Late Agricultural Chemist to Government, Punjab; P. E. Lander, M.A., D.SC., A.I.C., I.A.S., Agricultural Chemist to Government, Punjab, Lyallpur; and M. Mukand Lal, L.AG., Research Assistant, Agricultural College, Lyallpur.	Ditto
5	The Improvement of Fodder and Forage in India (Papers read before a joint meeting of the Sections of Agriculture and Botany, Indian Science Congress, Lucknow, 1923). Pusa Agricultural Research Institute Bulletin No. 150. Price, As. 6.	Edited by Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist, Pusa.	Ditto
6	Agricultural Statistics of India, 1920-21, Vol. II. Price, R. 1-8.	Issued by the Department of Statistics, India.	Ditto
7	Water Hyacinth. Bengal Department of Agriculture Leaflet 1 (English).	R. S. Finlow, B.SC., F.I.C., Director of Agriculture, Bengal.	Bengal Government Press, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
8	Water Hyacinth. Bengal Department of Agriculture Leaflet 2 (English).	R. S. Finlow, B.Sc., F.I.C., Director of Agriculture, Bengal.	Bengal Government Press, Calcutta.
9	Reaping of broadcast highland Aus paddy.	Issued by the Department of Agriculture, Bengal.	Ditto
10	Improvement of Cattle and provision of Cattle Fodder in Bengal (in English).	Ditto	Ditto
11	Annual Report of the Department of Agriculture, Bihar and Orissa, 1922-23.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Gulzarbagh.
12	Agricultural Statistics of Bihar and Orissa for 1922-23.	Ditto	Ditto
13	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1923.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
14	Annual Report on the Agricultural Stations in the Central Circle, United Provinces, for the year 1922-23.	Ditto	Ditto
15	Report on the Agricultural Stations of the Western Circle, United Provinces, for the year ending 31st May, 1923.	Ditto	Ditto
16	Report on the Agricultural Stations in the Eastern Circle, United Provinces, for the year ending 31st May, 1923.	Ditto	Ditto
17	Report on the Agricultural Stations in the North-Eastern Circle, United Provinces, for the year 1922-23.	Ditto	Ditto
18	Report on the Working and the Administration of the United Provinces Government Gardens for the year 1922-23.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
19	Season and Crops Report, Punjab, for 1922-23. Price, R. 1-8 or 2*s.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
20	Report on the Operations of the Department of Agriculture, Punjab, for the year ending the 30th June, 1922. Part II. Price, Rs. 7-10 or 10*s.* 2*d.*	Ditto	Ditto
21	Tables of Agricultural Statistics of Punjab for the year 1922-23.	Ditto	Ditto
22	Report on the Lawrence Gardens, Lahore, for the year 1922-23. Price, As. 5-6 or 5*d.*	Ditto	Ditto
23	Pamphlet entitled "Possibilities of Agricultural Development in the Punjab."	Sir Patrick Fagan, K.C.I.E., C.S.I.	Ditto
24	Notice for the guidance of Zemindars regarding Seed selection for sowing of Wheat (Urdu).	Issued by the Department of Agriculture, Punjab.	Mufid-i-Am Press, Lahore.
25	Report on the Cotton Survey of the Rohtak District in 1919. Price, Rs. 7 or 9*s.* 4*d.*	D. Milne, B.Sc., Economic Botanist to Government, Punjab; Ch. Ali Mohammad, L.Ag., and L. Kirpa Ram, L.Ag., Agricultural Assistants.	Government Printing, Punjab, Lahore.
26	Sugarcane type Coimbatore 205. Punjab Department of Agriculture Leaflet No. 22.	Malik Sultan Ali, Deputy Director of Agriculture, Gurdaspur.	Ditto
27	Clean Picking and Marketing of Cotton. Punjab Department of Agriculture Leaflet No. 23.	Issued by the Department of Agriculture, Punjab.	Ditto
28	Improvement of Grazing Areas in the Bombay Presidency. Bombay Department of Agriculture Bulletin No. 112 of 1923. Price, As. 11-6.	L. B. Kulkarni, M.Ag., Assistant Economic Botanist, Poona.	Government Central Press, Bombay.
29	Agricultural Advancement in the Nellore Taluk by Co-operation with the Agricultural Department. Madras Department of Agriculture Leaflet No. 30 (English and Telugu).	Subbarama Reddi of Thotapalli.	Government Press, Madras.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
30	Breeding and Rearing of Cattle and Buffaloes. Madras Department of Agriculture Leaflet No. 31 (English, Tamil, Telugu, Malayalam and Kanarese).	R. W. Littlewood, N.D.A., Deputy Director of Agriculture for Live-Stock, Madras.	Government Press, Madras.
31	Notes on the Exhibits at the Agricultural Exhibition, IV Circle, Madras, comprising North Arcot, South Arcot, Chingleput and Chittoor Districts. Madras Department of Agriculture Leaflet No. 33 (English and Tamil).	D. Ananda Rao, B.Sc., Deputy Director of Agriculture, IV Circle, Madras.	Ditto
32	An Improved Furnace for Jaggery making in Chittoor District. Madras Department of Agriculture Leaflet No. 34 (English, Tamil and Telugu).	Ditto	Ditto
33	The Ground, Earth or Pea-nut (*Arachis hypogæa*). Madras Department of Agriculture Bulletin No. 87. (Revised edition of Bulletin No. 28).	Issued by the Department of Agriculture, Madras.	Ditto
34	Year Book, 1923, of the Madras Agricultural Department.	Ditto	Ditto
35	Appendix A to "A Popular Account of the work of the Madras Agricultural Department" (Tamil and Telugu).	Ditto	Ditto
36	Report on the working of the Department of Agriculture, Central Provinces, for 1922-23. Price, R. 1.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
37	Return of expenditure on Provincial and District Gardens, Central Provinces and Berar, for 1922-23. Price, As. 4.	Ditto	Ditto
38	Report on the Cattle-breeding Operations in Central Provinces and Berar for 1922-23. Price, As. 4.	Ditto	Ditto
39	Report on the Demonstration work carried out in the Western Circle, Central Provinces, for 1922-23. Price, As. 8.	Ditto	Ditto

LIST OF AGRICULTURAL PUBLICATIONS—*cont.d.*

No.	Title	Author	Where published
	General Agriculture—contd.		
40	Report on the Demonstration work carried out in the Northern Circle, Central Provinces, for 1922-23. Price, As. 8.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
41	Report on the Nagpur Agricultural College, the Botanical, Chemical, Mycological and Engineering Sections and Maharajbagh Menagerie, Central Provinces. Price, As. 8.	Ditto	Ditto
42	Olpad Thresher. Central Provinces Department of Agriculture Leaflet (Hindi).	E. A. H. Churchill, B.Sc., Assistant Director of Agriculture, Central Provinces.	Ditto
43	The Cultivation of Oranges in the Central Provinces and Berar. Central Provinces Department of Agriculture Bulletin No. 19.	K. P. Shrivastava, Assistant to the Economic Botanist, Central Provinces.	Ditto
44	Report of the Agricultural Department, Assam, for the year ending 31st March, 1923.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
45	Tables of Agricultural Statistics of Assam for the year 1922-23.	Ditto	Ditto
46	Agricultural Statistics of Burma for the year 1922-23. Price, R. 1-8.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma.
47	The Bengal Agricultural Journal (Quarterly). (In English and Bengali.) Annual subscription R. 1-4; single copy As. 5.	Issued by the Department of Agriculture, Bengal.	Sreenath Press, Dacca.
48	The Journal of the Madras Agricultural Students' Union (Monthly). Annual subscription Rs. 4.	Madras Agricultural Students' Union.	The Electric Printing Works, Coimbatore.
49	Quarterly Journal of the Indian Tea Association. Price, Av. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press Calcutta.
50	Poona Agricultural College Magazine (Quarterly). Annual subscription Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press Poona.
51	Journal of the Mysore Agricultural and Experimental Union (Quarterly). Annual subscription Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press Bangalore.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—concld.		
52	Indian Scientific Agriculturist (Monthly). Annual subscription Rs. 4.	Alliance Advertising Association, Ltd., Calcutta.	Calcutta Chromotype Company, 52-3, Bow Bazar Street, Calcutta.
53	The Planters' Chronicle (Weekly).	United Planters' Association of South India, Coimbatore.	E. P. Works, Coimbatore.
	AGRICULTURAL CHEMISTRY		
54	A Preliminary Note on the Decomposition of Calcium Cyanamide in South Indian Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. VII, No. 3. Price, As. 12 or 1s.	Roland V. Norris, D.Sc., F.I.C., Government Agricultural Chemist, Coimbatore; B. Viswanath, Assistant Agricultural Chemist, Coimbatore; and C. V. Ramaswami Ayyar, L.Ag., Assistant to the Government Agricultural Chemist, Coimbatore.	Messrs. Thacker, Spink & Co., Calcutta.
55	The Prevention of Nuisances caused by the Par-boiling of Paddy. Pusa Agricultural Research Institute Bulletin No. 146. Price, As. 5.	J. Charlton, B.Sc., A.I.C., Agricultural Chemist, Burma.	Government Printing, India, Calcutta.
56	A Method for the accurate Determination of Carbonic Acid present as Carbonate in Soils. Pusa Agricultural Research Institute Bulletin No. 151. Price, As. 2.	Phani Bhusan Sanyal, M.Sc., Assistant to the Imperial Agricultural Chemist, Pusa.	Ditto
57	Liming of Assam Soils. Assam Department of Agriculture Bulletin No. 2 of 1923.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
58	Par-boiling of Paddy. Burma Department of Agriculture Leaflet No. 18.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
	BOTANY		
59	Studies in Inheritance in Cotton, I. History of a Cross between *G. herbaceum* and *G. neglectum*. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 3. Price, R. 1-4 or 1s. 9d.	G. L. Kottur, M.Ag., Cotton Breeder, Southern Mahratta Country.	Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
		Botany—concld.	
60	Studies in Indian Oil Seeds. No. 2. Linseed. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 4. Price, R. 1-4 or 2s.	Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist; and Abdur Rahman Khan, Assistant to the Imperial Economic Botanist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
61	Studies in Gujarat Cottons, Part II. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XII, No. 5. Price, R. 1-12 or 3s.	Maganlal L. Patel, B.AG., Cotton Breeder, South Gujarat.	Ditto
		MYCOLOGY	
62	The Relative Responsibility of Physical Heat and Micro-organisms for the hot weather Rotting of Potatoes in Western India. Pusa Agricultural Research Institute Bulletin No. 148. Price, As. 5.	S. L. Ajrekar, B.A., Acting Professor of Botany, Royal Institute of Science, Bombay; and J. D. Ranadive, B.AG., Assistant Mycologist, Potato Research Committee, Bombay Department of Agriculture.	Government Printing, India, Calcutta.
63	Some common Fungoid Diseases of Crops and their preventive measures—Ufra or Dak Disease of Paddy (in English and Bengali).	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Calcutta.
		ENTOMOLOGY	
64	List of Publications on Indian Entomology, 1922. Pusa Agricultural Research Institute Bulletin No. 147. Price, As. 7.	Compiled by the Imperial Entomologist.	Government Printing, India, Calcutta.
65	The Pest Act and Cotton. Madras Department of Agriculture Leaflet No. 32. (English and Tamil).	G. R. Hilson, B.SC., Cotton Specialist, Madras.	Government Press, Madras.
66	Mango Weevil (English and Bengali).	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Calcutta.
67	The Important Insect Pests of Coconut. Burma Department of Agriculture Leaflet No. 14. (Revised and enlarged.)	Issued by the Department of Agriculture, Burma.	Government Printin Burma, Rangoon.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	Entomology—concld.		
68	The Palm Beetles in Burma. Burma Department of Agriculture Bulletin No. 19.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
	AGRICULTURAL BACTERIOLOGY		
69	Indigo Experiments, 1922. (1) The effect on produce when Vat Liquor is allowed to stand in the beating vat and beating is delayed; (2) The effect of neutralizing the Liquor with caustic soda before beating. Pusa Indigo Publication No. 12. Price, As. 4.	J. H. Walton, M.A., M.Sc., Assistant Agricultural Bacteriologist, Pusa.	Government Printing, India, Calcutta.
	VETERINARY		
70	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1922-23. Price, R. 1-8.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
71	Cattle Census Report, Punjab, for the quinquennium ending 1922. Price, As. 8 or 8*d*.	Ditto	Ditto
72	Punjab Cattle Census of 1923. Price, As. 8 or 8*d*.	Ditto	Ditto
73	List of Horse and Cattle Fairs and Shows in the Punjab during 1923-24.	Ditto	Ditto
74	Annual Administration Reports of the Bombay Veterinary College, Glanders and Farcy Department, and Civil Veterinary Department in the Bombay Presidency (including Sind) for the year 1922-23. Price, As. 5.	Issued by the Civil Veterinary Department, Bombay.	Government Central Press, Bombay.
75	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for the year 1922-23. Price, As. 12.	Issued by the Civil Veterinary Department, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
76	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1923. Price, R. 1-2.	Issued by the Civil Veterinary Department, United Provinces.	Government Press, United Provinces, Allahabad.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title	Author	Where published
	Veterinary—concld.		
77	Report of the Civil Veterinary Department, Assam, for the year 1922-23. Price, As. 8 or 9*d*.	Issued by the Civil Veterinary Department, Assam.	Assam Secretariat Printing Office, Shillong.
78	Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma, for the year ended the 31st March, 1923. Price, R. 1.	Issued by the Civil Veterinary Department, Burma.	Government Printing, Burma, Rangoon.
79	Report of the Civil Veterinary Department of the Central Provinces and Berar for the year 1922-23. Price, R. 1.	Issued by the Civil Veterinary Department, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
80	Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1922-23. Price, As. 13.	Issued by the Civil Veterinary Department, N.-W. F. Province.	North-West Frontier Province Government Press.